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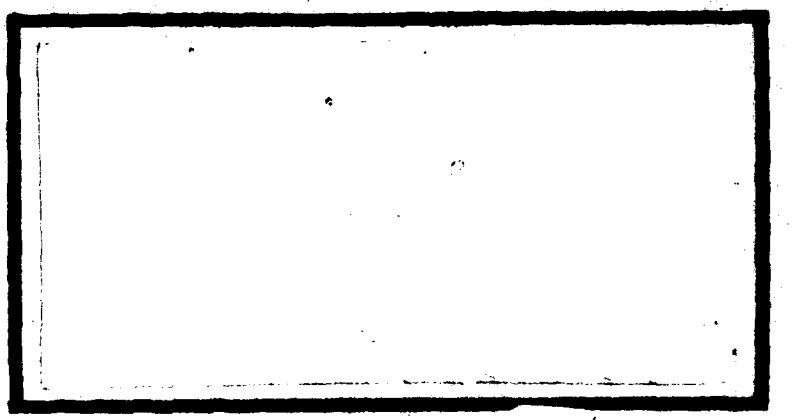

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COST IMPACT INVESTIGATION OF AFLC UNFUNDED TYPE I (CONTRACTOR) TRAINING

(10) John N. Allen, Second Lieutenant, USAF
Carl J. Wiles, Jr., Captain, USAF

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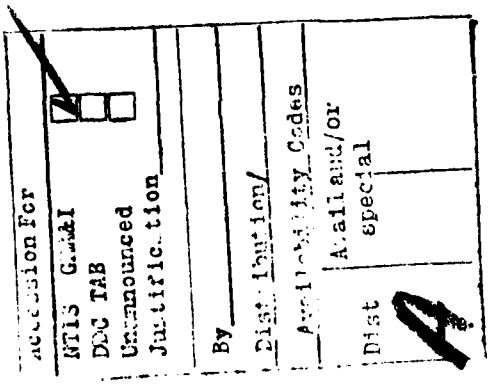

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This research was initially designed to investigate the cost impact on AFLC imposed by the shortage of (ATC) Type 1 training funds in FY79. Specifically, the research objective was to compare costs incurred by AFLC as a result of implementing continued contractor support or Contractor Engineering Technical Services for programs which could not be supported by ATC funded Type 1 training. It was intended that cost data be compiled from ATC and AFLC to (1) determine if there exists a statistical relationship between the estimated cost of unfunded Type 1 training and the cost of the above alternatives when used as a result of no training; and (2) compare training costs with alternative costs to determine the cost effectiveness to the Air Force of implementing alternatives compared to funding Type 1 training. The study encountered significant problems, however, in attempting to retrieve alternative cost data from the AFLC Air Logistics Centers. The study was thus diverted to investigating these problems and relating the research objective to the FY80 funding situation. An explanation of the proposed statistical methodology and application to hypothetical data is provided in the Appendix to support future research in this area.

LSSR 13-80

COST IMPACT INVESTIGATION OF AFLC UNFUNDED TYPE I (CONTRACTOR) TRAINING

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Facilities Management

By

John N. Allen, BSEE
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June 1980

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This thesis, written by

Second Lieutenant John N. Allen

and

Captain Carl J. Wiles, Jr.

has been accepted by the undersigned on behalf of the faculty of the School of Systems and Logistics in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN FACILITIES MANAGEMENT

DATE: 9 June 1980

COMMITTEE CHAIRMAN

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CHAPTER I

INTRODUCTION

Special training, more specifically contractor-conducted special training, required to support Air Force systems acquisition programs is becoming an area of growing fiscal concern. This concern is a product of the requirements for more sophisticated and thereby more expensive training, the effects of inflation, and the current public concern for defense expenditures. It is estimated that USAF-contractor training requirements will exceed $20 million in FY80 and $33 million in FY81 (1).

Contractor-conducted training is utilized to upgrade USAF personnel who will be supporting new weapons and support systems during testing and subsequent deployment. Delays or other problems in the training planning can result in cost and/or schedule impacts on the acquisition program. A recent problem in this area has been a shortage in the funds available for purchasing necessary contractor training (16; 28).

Background

To complement the background discussion, the narrative will be integrated with a systems approach (18) to enhance the reader's understanding. Several subsystems

will be developed in the background discussion. Each subsystem will incorporate an input, a process, and an output as illustrated in Figure 1. At the end of the background discussion, the subsystems will be incorporated into an overall system diagram.

Fig. 1. Basic System

Special training is defined by Air Force Regulation (AFR) 50-9, Special Training, to be formal training

> . . . designed to provide experienced military and civilian personnel with additional or upgraded skill in the operation, maintenance, repair, overhaul, setup, and checkout, programming, analysis, software design, engineering aspects of Air Force equipment or systems, and information on operational techniques and procedures [24:2].

Major command-identified special training requirements are satisfied by Air Training Command (ATC) through utilization of existing ATC, USAF, or Department of Defense (DOD) training courses or by purchasing training from civilian contractors, educational institutions, or other government agencies. Four types of special training are defined by AFR 50-9 as follows:

a. Type 1 . . . . factory training . . . established to qualify Air Training Command (ATC) instructors and to provide an initial cadre of skilled maintenance, aircrew, system operator, or other type personnel required by the major commands.

b. Type 2. Special training conducted by ATC instructors normally at an ATC base. This training is often conducted as a continuation of, and sometimes concurrently with a Type 1 special course to train personnel of the major commands.

[Type 3. Resident training of a continuing nature conducted by ATC which includes basic, lateral, advanced, and supplemental courses. These courses are identified in AFM 50-5, USAF Formal Schools Catalog (25), and are not included in AFR 50-9.]

c. Type 4. Special training provided by ATC Field Training Detachments . . . or mobile training teams (MTTs).

d. Type 5. Special training arranged for by ATC which is conducted by other US Government Agencies or major commands other than ATC [24:3].

Special training requirements are identified by the major commands via Air Force Form 403, "Request for Special Technical Training," and may be satisfied by one or more of the above types of special training. Training requests received by ATC are forwarded to the appropriate System Training Manager (STM), who may be located at Headquarters ATC or at one of four technical training centers. The STM determines the type(s) of training required to satisfy the request (Figure 2). If Type 1 training is required, the STM will compute an estimated cost for the training and assess the funding priority of the program.

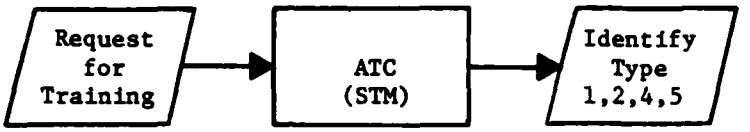


Fig. 2. ATC Selection of Training Type

When special training requirements are in support of USAF systems acquisition programs, training is frequently not available within DOD and Type 1 training must be purchased. This training is then used to meet major command initial trained personnel requirements and frequently forms the basis for follow-on Type 2, 3 and/or 4 training programs to meet future trained personnel requirements.

In accordance with AFR 50-9, "Air Training Command has been delegated Air Force-wide responsibility as the sole purchaser of Type 1 training [24:3]." ATC is responsible for surveying and screening major command training requirements, budgeting for Type 1 training, and establishing a program priority system for the control of training programs within funding limitations (24:7) (see Figure 3).

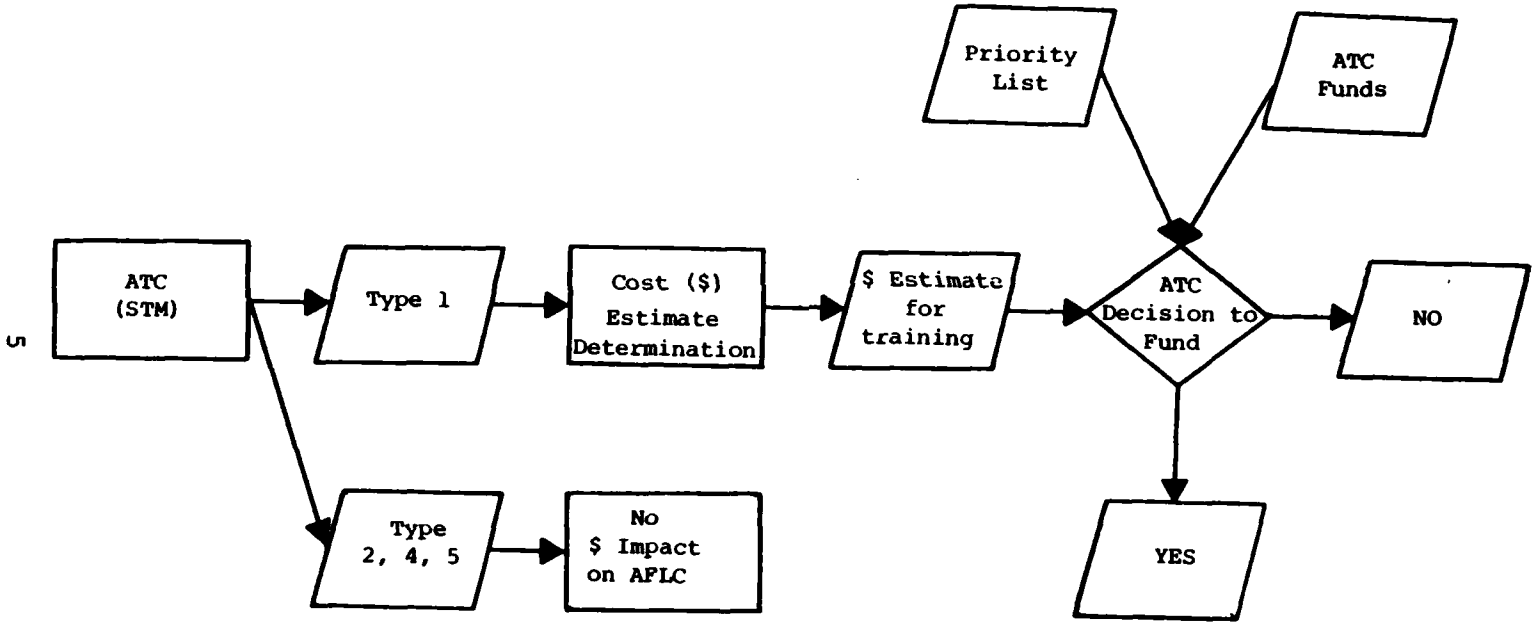


Fig. 3. ATC Decision Subsystem

In recent years, USAF Type 1 training requirements have exceeded ATC funding capabilities, as indicated in ATC correspondence for FY78 and 79. In a 1978 letter (28) to Deputy Chief of Staff (DCS)/Systems, Headquarters Air Force Systems Command (AFSC/SD), and DCS/Logistics Operations, Air Force Logistics Command (AFLC/LO), Brigadier General Vojvodich, DCS/Technical Training (TT) for HQ ATC, identified a shortage of funds for FY78 and requested a prioritization of training requirements by the respective commands. Similar letters (16; 17) were addressed to all major commands in FY79 by the Commander (CC) and Vice Commander (CV) of ATC identifying FY79 shortages.

This shortage in training funds necessitated a coordinated effort between ATC and the major commands to ensure effective and efficient utilization of the limited funds. FY79 funding limitations were the most serious, as expressed by General John W. Roberts, as Commander of ATC, in a letter to the commanders of all major commands:

> Earlier this year we advised you of a serious deficiency in contract training funds. We initially received funding in the amount of $5.1M against MAJCOM-stated requirements of $9.1M. Our funding level was subsequently reduced to $3.1M. The end result is that many of the critical training requirements in support of operational systems cannot be funded [16].

ATC subsequently received supplemental funding in July 1979 in the amount of $3.0 million; however, this was still $3.0 million below FY79 requirements (22).

Of the $3.1 million initially available for Type 1 training in FY79, $1.1 million was identified for depot level maintenance support training for AFLC personnel (8). AFLC minimum requirements exceeded this figure by $2.8 million as identified by General Bryce Poe II, AFLC Commander, in an impact letter to General Lew Allen, Jr., Chief of Staff of the Air Force (13). Impacts for various programs identified in this letter included delay of organic depot capability, a need to contract for expensive contractor support, hazards to personnel attempting to operate equipment without adequate training, idle depot equipment, and slower response time for depot support.

In response to the funding shortage of FY78 and FY79, ATC/TT and ATC/CC respectively (28; 16) requested that all major commands, including AFLC, provide cost impact statements on affected command programs. These statements were used as an additional input in prioritizing training requirements to ensure that limited funds were appropriately allocated. The statements were also included as funding justification in the supplemental training funding requests submitted to Air Staff by AFLC and ATC.

Problem Statement

As a result of a shortage in training funds and inadequate supplemental funding, AFLC must implement unplanned and unbudgeted alternatives to satisfy depot support requirements. Personal interviews with HQ AFLC personnel from Logistics Management and Training (4), Resources and Management Engineering (9), and Employee Development and Training (5) and HQ ATC correspondence from Colonel Robert F. Brodman, Director of Systems Training, to the Military Education and Training Division (HQ AFLC/DPMTT) (2) provided the following list of AFLC alternatives:

1. Delay the organic depot capability, continue with contractor depot support, and resubmit the training request in the next fiscal year;

2. Contract for Contractor Engineering Technical Services (CETS) to provide on-the-job training[1] and technical support (23);

3. Fund for required Type 1 training by providing obligation authority to ATC or by AFLC training contracts, the latter of which requires waiver from AFR 50-9;

---

[1]Under CETS, a technical representative is assigned to the depot for a specified period of time to provide informal training and technical guidance as required on designated equipment. Training may include informal classroom instruction; however, it does not provide the depth or quality of training provided by formal Type 1 classroom training (24:3; 23:1-1 to 1-2).

4. Develop and implement an in-house training program to qualify depot personnel.

The selection of an alternative by AFLC is illustrated in Figure 4.

Determination of the cost impact (opportunity cost) of implementing alternatives to date has been a reactive process in response to requests from ATC. Also, until FY79 HQ AFLC did not typically become involved in the funding process as the logistics centers coordinated directly with ATC (5). Beginning in FY80, all training requirements for AFLC logistics centers are submitted to ATC through HQ AFLC. Increased headquarters involvement in the planning process and the potential for future funding problems dictate a need for determining cost impacts at earlier stages in the planning process by personnel at headquarters level. To date, however, there does not appear to be a representative model available to headquarters personnel which relates the estimated cost of unfunded training programs to the cost impact (opportunity cost) to AFLC of implementing alternatives.

Justification

Interviews with training planning personnel from the Training Programs Division, DCS/Manpower-Personnel, HQ USAF (1); Aerospace Systems Division, Systems Training Division, HQ ATC (12); and Employee Development and

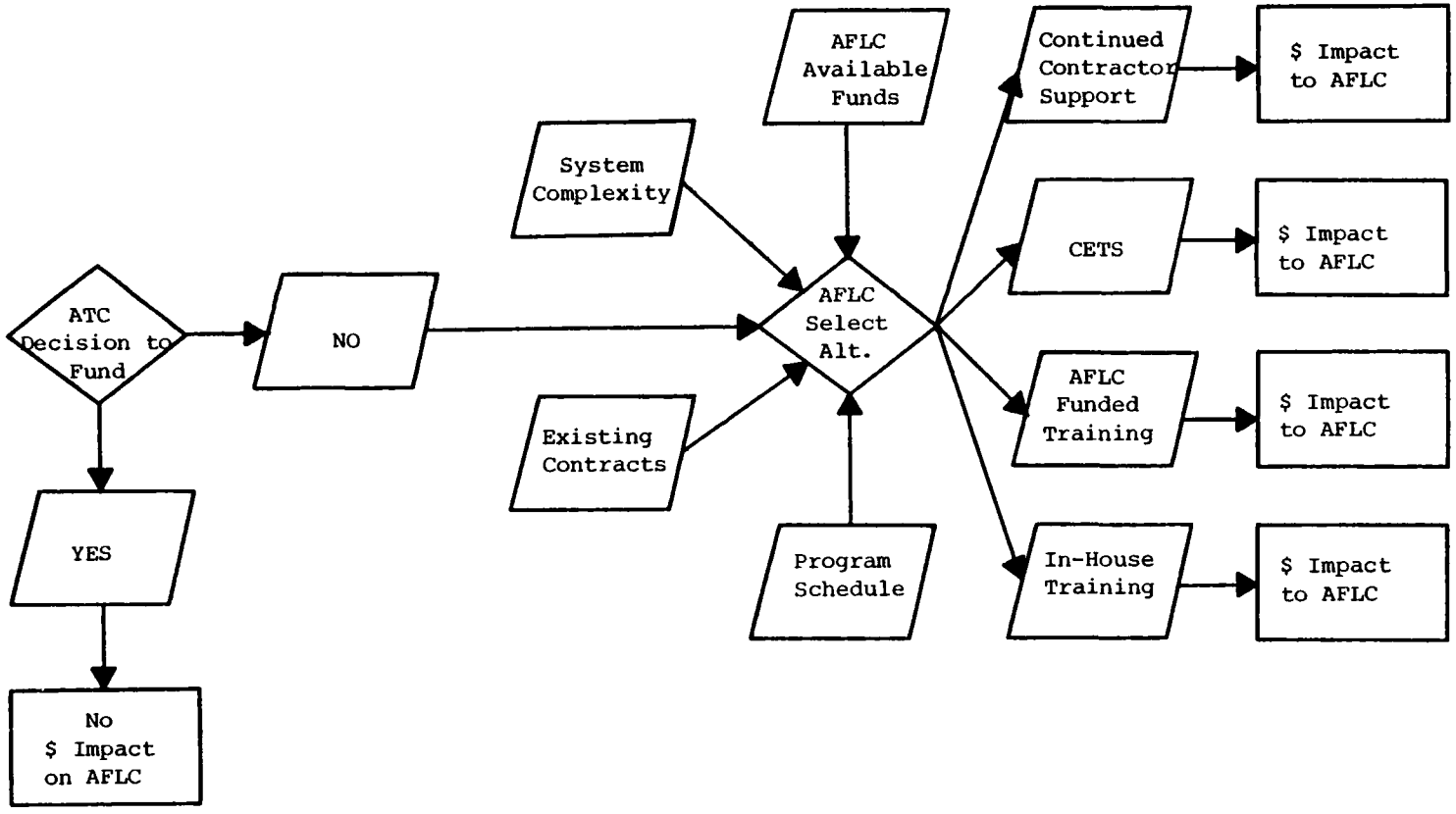


Fig. 4. AFLC Selection of Alternative

Training Division, HQ AFLC (5) indicate that such a model would provide a means of estimating the cost impact of unfunded training at the headquarters level. A model would enable planning personnel to estimate cost impact and minimize time-consuming and more costly impact computations by AFLC logistics centers. For ATC personnel, this capability would provide an additional input to the priority system used in allocating Type 1 training funds (see Figure 5). For AFLC and Air Staff personnel, the model would provide a means of predicting cost impacts and identifying potential problem areas. For personnel at ATC, AFLC, and Air Staff, the cost impact figures could be an input to the justification for supplemental funding for Type 1 training.

The problem of insufficient Type 1 training funds, although not a new problem, appears to be growing. For FY80 Type 1 training requirements are estimated at $26.0 million (22), which includes carry-over of unfunded requirements from FY79. Associated funding for Type 1 training for FY80 is currently estimated to be $11.2 million; the estimated shortage being $14.8 million. Such a shortage will demand attention at all levels to determine how the limited funds will be allocated and what the impact of unfunded training programs will be. The availability of a valid, respresentative model will not

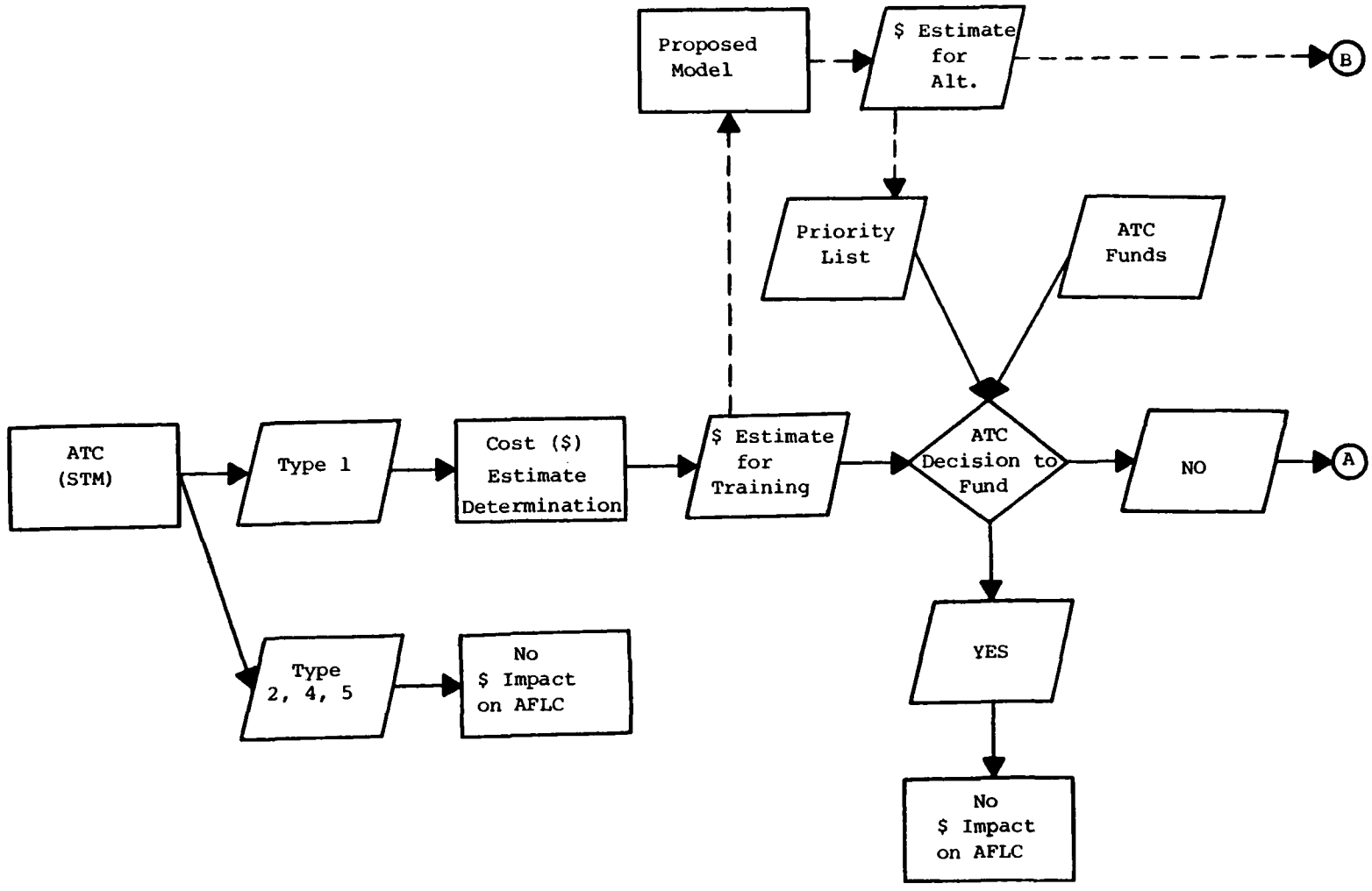


Fig. 5. Total System with Model Input

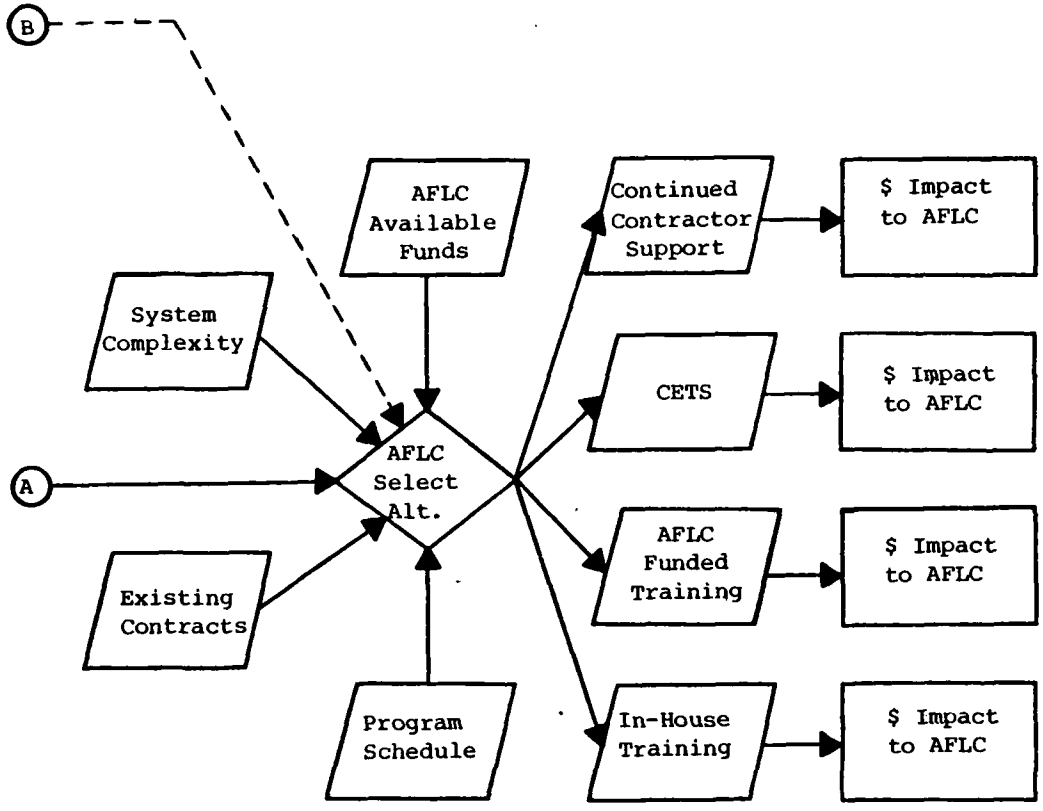


Fig. 5.--Continued

solve the funding problem; however, it would provide useful inputs to the planning process.

Scope

This research was conducted with primary emphasis on the costs of the first and second alternatives identified in the problem statement. The cost impact to AFLC of funding for Type 1 training, the third alternative, is known once the estimated cost of training is determined. Information was also gathered when available on the cost of in-house training, the fourth alternative; however, in many cases these costs were difficult to distinguish from the day-to-day operating costs of the logistics centers.

Research Objective

The objective of this research was to investigate the relationship between the estimated cost of Type 1 training and the cost of implementing unplanned CETS and/or continued contractor support, hereafter referred to as alternatives, as a result of unfunded training.

Research Propositions

1. There exists a positive linear relationship between the estimated training cost and the cost to AFLC of implementing alternatives.

Discussions with AFLC personnel suggest that alternative costs are proportional to estimated training costs, therefore, a positive relationship is proposed. Linearity, or at least piece-wise linearity, is proposed to provide planning personnel with a representative but easily applied model.

2. It would be more cost effective for the Air Force to provide adequate funds to ATC to satisfy AFLC training requirements than to have AFLC implement alternatives.

Preliminary research indicates that alternative costs are greater than the associated estimated training costs. This implies that it would be more cost effective for the Air Force to meet ATC budgetary requests to support AFLC training requirements than to have AFLC implement alternatives. If Proposition 1 is concluded, cost effectiveness could be determined based upon model output.

Plan of the Report

The presentation plan for this report is as follows:

Chapter I includes the background and problem statement followed by justification for the study. The scope of the research is outlined and the research objective and propositions to be investigated are defined.

Chapter II presents the research methodology including definition of the research variables and description of the data collection and analysis plan. The chapter closes with a listing of the research assumptions and limitations.

Chapter III provides a statistical and narrative summary of the data collected from the AFLC Air Logistics Centers (ALCs). Findings derived from personal and telephone interviews related to (1) the ALC responses, (2) barriers to more comprehensive data collection, and (3) FY80 training funding are presented and discussed with respect to the research propositions.

Chapter IV presents the research conclusions and closes with recommendations for improved fiscal control in the area of training funding and areas for further study.

CHAPTER II

METHODOLOGY

This chapter presents a description of the data collection and analysis procedures used to investigate the relationship between estimated costs for unfunded training and the cost to AFLC to implement alternatives. The populations studied are defined and the data collection plan is described, including a discussion of the problems encountered during the data collection process. These problems necessitated changes in the data analysis procedure and are included in this report, as they are pertinent to the results and conclusions of this study. This chapter closes with a summary of the assumptions and limitations associated with this research.

Definition of Populations

This research was initiated with the intent of conducting a statistical analysis to study the relationship suggested by the first Research Proposition. With that goal in mind, three populations were identified for study:

1. The estimated cost of AFLC Type 1 training requirements which were not funded in FY79.

2. The cost to AFLC of continued contractor support when used as an alternative to Type 1 training and an organic capability.

3. The cost to AFLC of CETS when used as an alternative to Type 1 training to provide informal personnel training.

For the statistical analysis, the above data was to be divided into paired samples consisting of the estimated training cost of unfunded training programs (population 1) and the respective cost of the alternative implemented by AFLC as a result of no Type 1 training (population 2 or 3).

The selection of the three populations was based on two considerations:

1. The use of FY79 data was made with the assumptions that planning personnel would still be relatively familiar with FY79 problems and data would be readily available; and

2. Conclusions drawn upon FY79 data analysis could be extended to future years. That is, if a representative model was developed it could be applied to future year fiscal planning, as it was assumed that inflation and advancements in technology would have the same effects on both training and alternative costs such that the model would still be representative.

Definition of Variables

The independent variable for this research was the estimated cost of the Type 1 training programs required by AFLC in FY79 which were not funded.

The dependent variables were the cost of associated AFLC alternatives, continued contractor support or CETS, implemented as a result of unfunded training.

Data Collection and Analysis Plan

Data collection was designed as a sequential process starting with a survey of all training requests submitted by AFLC in FY79 and concluding with the determination of alternative costs for associated unfunded training programs. The process was initially proposed to be comprehensive in that an attempt was made to determine alternative costs for all unfunded AFLC Type 1 training programs. This attempt was later found to be futile and a change in research strategy was necessitated, as will be described later in this chapter.

Data collection began with a survey of all Air Force Form 403s submitted by AFLC which identified FY79 special training requirements. This was accomplished by reviewing all 403s on file with the Programs Division, DCS/Technical Training (HQ ATC/TTPP), Randolph Air Force Base TX, which is the organization responsible for

receiving and processing all 403s submitted to ATC by the major commands (24:11).

Records maintained at TTPP, in addition to the 403s, provided information on the action taken on each 403 by the STM, including type of training required to satisfy the training request (Figure 2). The survey consisted of noting all 403s which were identified to require Type 1 training and all other 403s which were not identified for a particular type of training (Types 2, 4, or 5). Therefore, the survey produced a list of all training requests submitted by AFLC which were identified to require Type 1 training or were possible candidates for Type 1 training in FY79.

The next step in the data collection process was to determine the funding status of each program. This was initially attempted through personal and telephone interviews with personnel from Systems Training Division, HQ ATC/TTY, and training personnel from each of the AFLC logistics centers, XX-ALC/DPCT. The interview mode of data gathering, however, was found to be very time consuming and not always productive. Personnel were sometimes not available or the information required was not immediatley available to them, necessitating a follow-up interview.

As a result, it was decided that a letter request to each of the Air Logistics Centers (ALCs) would

be a more effective means of gathering the research data. A letter was drafted for AFLC/DPC signature and forwarded to each of the ALCs with an attachment listing the 403s identified against each respective ALC as compiled during the ATC/TTPP survey. A copy of the letter request without attachments is provided as Appendix A.

In accordance with the letter, each ALC was tasked to provide the following information for each 403 listed in the letter attachment (five different attachments were made, each listing 403s for the respective ALC):

1. Identification of the final status of each 403 based on the following definitions:

a. Deferred (D): Type 1 was no longer required in FY79 due to changes in the program schedule or program requirements.

b. Funded (F): Type 1 training was contracted and funded by ATC.

c. Unfunded (UF): Type 1 training was required; however, ATC funding was not available to contract for the training. (For this research, Type 1 training funded by AFLC was considered unfunded, as AFLC funding was identified as an alternative.)

d. Satisfied (S): Training requirement was satisfied by Type 2, 3, 4, and/or 5 training arranged by ATC.

e. Other (O): Status was other than above; explanation required.

2. For each 403 identified as unfunded, identification of the alternative implemented as a result of no training funding by ATC. The following alternatives were provided; however, other alternatives could be used when appropriate:

a. Continued contractor support (CS)

b. In-house training (IH)

c. Contractor Engineering Technical Services (CETS)

d. AFLC obligation authority to ATC for contracting (OA)

e. ALC contract (and funding) for training (AT)

3. For each 403 identified as unfunded, identification of the cost impact of the alternative implemented and the estimated training cost if available.

The attachments were designed such that ALC personnel could respond on the attachments using the codes listed above and provide cost figures when required.

It was anticipated, after subsequent telephone contacts with each of the five ALCs, that this method of data gathering would provide sufficient data pairs to permit a statistical analysis and evaluation of the research propositions. As stated earlier in this chapter, however,

the attempt to gain cost impact figures on the alternatives implemented was found to be futile upon receipt of the replies from the ALCs (Appendices B through F). That is, although information was gained from the replies, cost data were not provided in sufficient quantity to enable a statistical analysis or derive any conclusions as to the relationship between the estimated training costs and alternative costs.

At this point in time it was necessary to step back and take another look at the training funding problem and the strategy for this research. The objective remained valid; however, the assumption made early in the research that FY79 data would be readily available was obviously not a valid assumption. It was, therefore, proposed to investigate the problems or issues associated with training funding at the ALC and Headquarters levels, and determine why more data were not obtained. Also, it was decided that a demonstration of the proposed statistical analysis should be included in this report to provide planning personnel with a working example of the statistical methodology developed to investigate the research propositions. This demonstration would provide AFLC training personnel and ATC System Training Managers with a description of the statistical methodology, and an application of the methodology to hypothetical data. This methodology could then be applied when sufficient data were

accumulated to support a statistical study. The methodology initially proposed for this research is provided as Appendix G and the application of this methodology to hypothetical representative data is provided as Appendix H.

As a first step to investigating the training funding problem, a detailed summary of the ALC responses was compiled for each ALC and for the command. Statistics were computed for the total number of unfunded training requests and the total number of these which included a cost impact. The unfunded training requests were further classified by the alternatives previously identified such that each unfunded 403 could be identified against one of seven categories:

1. Continued contractor support (CS)
2. In-house training (IH)
3. Contractor Engineering Technical Services (CETS)
4. AFLC obligation authority (OA) to ATC
5. AFLC training funding and contract (AT)
6. Personnel received training but method not specified
7. No alternative given.

The results of the above analysis and general conclusions drawn from the statistics are provided in the "Data Analysis" section of Chapter III.

Additional information was also sought concerning the responses by again going to the telephones. Each ALC point-of-contact (6; 7; 14; 19; 20) was asked the following questions to provide additional background on the completion of the responses:

1. Was the response accomplished independently by DPCT personnel or in coordination with using agencies?

2. Why were more cost impact figures not provided?

3. What was the general impact of no Type 1 training?

The responses to these questions are provided in the "Findings" section of Chapter III.

Subsequent to the above interviews, additional personal interviews were conducted with Headquarters AFLC personnel to discuss the results of the ALC survey and the training funding problem. Question 2 above was posed to headquarters personnel and potential barriers to obtaining cost impact figures from the ALCs were discussed. Finally, current information on the status of FY80 Type 1 training funding was discussed and related to the objectives and findings of this research. The results of these interviews are provided in the "Findings" section of Chapter III.

Research Assumptions

The following assumptions apply to this research:

1. It was initially assumed that FY79 data for Type 1 training and alternative costs would be readily available to support a statistical analysis; however, this was later found to be invalid.

2. It was assumed that AFLC Type 1 training requirements were limited to those from the five Air Logistics Centers. Requirements of the Aerospace Guidance and Metrology Center (AGMC), Newark Air Force Station, Ohio, and 2750 Air Base Wing, Wright-Patterson Air Force Base, Ohio, were not included in the research. This assumption was made to eliminate any unique effects which might be induced in the relationship investigation by these latter two organizations when compared to the operations of the five ALCs. The five ALCs were assumed to be similar in function and operation for this research.

3. If a relationship and model could be developed from past data, it could be applied to and be representative of future years. It was assumed that inflation and advancements in technology would have the same effects on both trainng and alternative costs such that the relationship would be representative in future years.

4. Any assumptions made by ATC or the Air Logistics Centers in determining training or alternative costs were accepted by this study.

Research Limitations

The following limitations apply to this research:

1. Findings are limited to application to Type 1 training requirements of AFLC only.

2. Research was limited to information made available by the ALCs, which was not sufficient to draw any conclusions as to the relationship between training costs and alternative costs.

CHAPTER III

DATA ANALYSIS AND FINDINGS

This chapter begins with a summary and analysis of the responses received from the five ALCs. This summary is followed by a discussion of the results of the telephone interviews conducted with ALC training personnel during which the questions presented in Chapter II were answered. The results of the interviews conducted with Headquarters AFLC personnel are then presented and related to the objective of this research.

Data Analysis

This section presents a summary of the data gathered from the ALCs in their responses to the letter request provided as Appendix A. The responses for the five AFLC Air Logistics Centers--Oklahoma ALC (OC-ALC), Ogden ALC (OO-ALC), San Antonio ALC (SA-ALC), Sacramento ALC (SM-ALC), and Warner-Robins ALC (WR-ALC)--are provided as Appendixes B through F respectively.

The above attachments identified a total of three hundred and twenty-four 403s which were classified by ATC to require Type 1 training or were possible candidates for Type 1 training in FY79. In reviewing the data, the five ALCs provided virtually complete responses to the extent

that the funding status was identified for all but two of he 403s. (A follow-up telephone call to OO-ALC was made to obtain information on the two "unanswered" 403s; however, additional information was not available.) Therefore, it was possible to identify the 403s which were unfunded by ATC in FY79. The identification of the alternatives implemented as a result of no ATC funding, however, was not as complete. Only 56 percent of the 403s labelled as unfunded had any alternative indicated. More importantly for this study, only 13 percent of the unfunded 403s, or 24 percent of those for which an alternative was listed, included a cost impact. In general, the data provided in the "Alternative" and "Cost Impact" columns were limited and insufficient to support a statistical analysis. A summary of the responses is provided in Tables 1 and 2.

In reviewing the "Alternative" comments in the ALC responses, it was recognized that the status for some of the individual 403s was not consistent with the definitions provided in the letter. The most significant deviations were noted in the WR-ALC response (Appendix F):

1. Thirteen 403s were listed as Other (O) with the remark "Not funded by ATC for FY79, resubmitted for FY80." These 403s should have been identified as Unfunded (UF), with information provided as to what alternative was

Table 1

BREAKDOWN OF ALC RESPONSES
(by number and percentage of column total)

	OC-ALC	00-ALC	SA-ALC	SM-ALC	WR-ALC	TOTAL
Number 403s Listed	69	68	52	13	122	324
Deferred (D)	18	24(23)	14	0	74(61)	130
%	26%	35%	27%	---	61%	40%
Funded (F)	13	17	7	0	7	44
%	19%	25%	13%	---	6%	14%
Unfunded (UF)	32	23(25)	27	9	15(13)	106
%	46%	34%	52%	69%	12%	33%
Satisfied (S)	1	1(0)	0	2	0	4
%	1%	1%	---	15%	---	1%
Other (0)	5	1	4	2	26(41)	38
%	7%	1%	8%	15%	21%	12%
No Response	0	2	0	0	0	2
%	---	3%	---	---	---	1%

NOTE: Numbers of 403s are corrected for "status" errors; numbers in parentheses are actual numbers identified by the ALC. Percentages may not total due to rounding.

Table 2

BREAKDOWN OF 403s IDENTIFIED AS UNFUNDED
(by actual number and percentage of column total)

	OC-ALC	OO-ALC	SA-ALC	SM-ALC	WR-ALC	Total
Continued Contractor Sup. (CS)	9	0	2	0	0	11
%	28%	---	7%	---	---	10%
In-House Training (IH)	15	15	0	0	1	31
%	47%	65%	---	---	7%	29%
Cont. Eng. Tech. Ser. (CETS)	0	0	0	0	0	0
	---	---	---	---	---	---
Obligation Authority to ATC (OA)	8	4	0	1	0	13
%	25%	17%	---	11%	---	12%
AFLC Training Contract (AT)	0	2	0	0	0	2
%	---	9%	---	---	---	2%
Training Received Method Not Specified	0	0	0	1	0	1
%	---	---	---	11%	---	1%
No Alternative Given	0	2	25	7	14	48
%	---	9%	93%	77%	93%	45%
Unfunded 403s with Cost Impact	2	7	2	1	2	14
%	6%	30%	7	11%	13%	13%

NOTE: Percentages may not total due to rounding.

implemented, and at what cost impact, to satisfy the depot requirement in FY79.

2. Twelve other 403s were listed as unfunded (UF) with the remark "Delay in PMRT no FY79 impact." Per the definitions in the letter, these 403s should have been listed as Deferred (D), since the requirements were deferred due to program schedule changes.

Overall, twenty-nine responses were noted to be in error and were changed by the authors to comply with the definitions, based on the remarks provided in the "Alternative" column. The results of these changes are provided in Table 3.

The total number of 403s did not change, however, as a result of these corrections. Ironically, fourteen 403s were changed to unfunded status and fourteen other 403s were changed from unfunded to some other status. Only one of the twenty-nine 403s marked in error included a cost impact remark. Table 1 provides corrected and actual numbers of 403s in each status.

Before continuing, it is enlightening and appropriate at this point to reflect upon the results of a training workshop convened by HQ AFLC in May 79, which included representatives from each of the ALCs and appropriate Headquarters personnel. The purpose of the workshop was to reconfirm and prioritize FY79 Type 1

Table 3

403s AFFECTED BY STATUS CHANGE

ALC	403	Status Indicated by ALC	Corrected Status	Alternative Remark
OO	72S	UF	S	Received training at Newark
	836	UF	D	Slipped to FY81
WR	DO8	O	D	Not funded by ATC--being deferred by supv. til later date.
	D11 D20 D22 D23 D24 D25 D34 D37 D38 D39 D47 D50 D100	O	UF	Not funded by ATC, resubmitted as FY80 requirement.
	L20	O	UF	... paid by DMIF
	R06 R07 R08 R09 R17 R18 R33 R34 R35 R36 R38 R54	UF	D	Delay in PMRT no FY79 impact.

requirements per ATC request and outline procedures for FY80 and future training planning and funding. Ironically, when ALC representatives were asked to defend training requirements and provide mission/cost impacts, responses very similar to the subject responses were provided. In many cases, the impact of not receiving Type 1 training could not be provided, thus raising some question as to the validity of the training requirements (9).

Findings

This section presents the results of the telephone interviews conducted with the ALC Training Branches (DPCT) and the personal interviews conducted with Headquarters AFLC personnel. These interviews were conducted to investigate the problems and suspected barriers associated with compiling cost impact information. Also, updated information was obtained on the status of the training funding problem in FY80, which provided additional support for the objective of this research.

To gain additional information on the data collection process used to accomplish the ALC responses, each ALC Training Branch (DPCT) representative (6; 7; 14; 19; 20) was contacted and asked the questions posed in Chapter II. A summary of the replies to these questions is provided below.

QUESTION 1: Was the response accomplished independently by DPCT personnel or in coordination with using agencies?

In all cases, responses were completed by or in coordination with using agencies. Therefore, it would seem that more data should have been compiled than were provided in the responses, as utilization of CETS or continued contractor support (as a result of no ATC training funding) would have required contracts, with documented contract costs. Also, if using agencies were involved in the response completion process, it would seem that information should have been available on alternatives for all 403s listed as unfunded. The question which comes to mind is:

QUESTION 2: Why were more cost impact figures not provided?

Discussions with DPCT personnel and the letter responses indicated that in-house training (IH) is frequently the alternative implemented in reaction to no ATC funding. This informal training is typically limited to on-the-job training and does not satisfy the training requirements (6; 14; 19); although, an organic depot capability is achieved. The training requires on-duty time, does not generally provide the level of training provided by formal Type 1 courses, and may result in slower

response time by the depot. The cost impact of these intangible effects is obviously difficult to ascertain since they are part of day-to-day operating costs. It is interesting to note, however, that in two interviews (7; 20) it was indicated that in many cases in-house training satisfies the training requirement, and subsequent Type 1 training is not required. If this is the case, a question arises as to the validity of the original Type 1 training requirement. This logic may be extended to the responses. If some training requirements are submitted on a "nice-to-have" basis and do not represent a valid Type 1 requirement, then the lack of a cost impact figure seems logical. This issue is further discussed during presentation of the results from interviews with HQ AFLC personnel.

It was also suggested that continued contractor support, CETS, and AFLC training funding may have occurred more frequently than indicated in the responses. These alternatives do not involve DPCT coordination and, as a result, cost impact data are only available if provided by the using agencies. Probable reasons why using agencies may not have included these data in their responses are also provided later in this chapter during presentation of results from the HQ AFLC interviews.

QUESTION 3. What is the general impact of no Type 1 training?

The general impact of no formal Type 1 training as identified by the interviews was slower response time from the ALC and operation at less than full potential with affected equipment. Frequently, experience on new equipment is gained through self-training programs conducted by depot personnel to a level at which the required tasks can be accomplished, thereby achieving the organic depot capability. This in-house training typically involves on-the-job training gained over several months of actually working with and learning from the equipment and related technical orders, and does not generally result in the level of expertise provided by one or two weeks of Type 1 training. Type 1 training also provides training on all aspects and capabilities for which the equipment was designed, thus ensuring that personnel can operate equipment at its full potential. This result is not always achieved by in-house training. Although these operational impacts seem to be logical results of the training funding problem, it should be emphasized that this information is strictly based on the telephone interviews and, therefore, should be used with discretion as personal perceptions until more concrete evidence becomes available.

Programs supported by continued contractor support, CETS, or AFLC training funding obviously impose additional costs on AFLC, which are generally unplanned and unbudgeted. In selected cases, Depot Maintenance Industrial Funds (DMIF) were known to be used to fund training (6; 20). The effects of these costs were investigated during interviews with HQ AFLC personnel, the results of which are discussed next.

Following the telephone interviews with ALC personnel, personal interviews were conducted with HQ AFLC personnel from Employee Development and Training Division (DPCT) (5; 27), Financial Management Productivity and Analysis Division (MAJA) (21), and Resources and Management Engineering Division (MASR) (8). These interviews were less structured than the ALC interviews, since the offices contacted did not possess the uniformity in function and operation common to the five ALC Training Branches. Questions were specific to the office being interviewed and differed among the offices, although Question 2 of the ALC interviews was discussed with DPCT personnel.

The DPCT interviews provided findings on suspected problems in the data collection process and current information on the status of FY80 training funding. The most significant finding of these interviews

and other informal interviews conducted during this research was that the responses were considered incomplete with respect to the identification of alternatives implemented and associated cost impact. It is suspected that ALC personnel are reluctant to discuss past alternatives as funding for these alternatives may not always be consistent with operating regulations. For example, AFLC contracting for formal training is not authorized without a formal waiver to AFR 50-9 (24:3); however, informal conversations between HQ AFLC personnel and ALC personnel indicate that such training is purchased. Also, funding for this training is suspected to come from sources other than those authorized for formal training procurement. The use of DMIF funds was, until March 1980, not officially authorized for training procurement (15); nevertheless, interviews indicate that these funds were used in FY79 to purchase training by the ALCs (6; 20).

When an ALC is notified by ATC that funding is not available for a requested Type 1 training requirement, it must seek some other alternative to satisfy at least the current year's depot support responsibility. If CETS, continued contractor support, or AFLC funded training is selected as the alternative, the additional costs must be satisfied by available funds. It appears in satisfying this requirement the ALCs must at times provide justification for alternatives or utilize funding which is not

consistent with published directives. As a result, it is suspected by AFLC/DPCT personnel that ALC personnel are reluctant to provide documented information on these past actions.

Another problem arises in that there does not appear to be a requirement to monitor costs on alternatives implemented. As a result, the annual costs associated with implementing an alternative such as CETS or continued contractor support are "buried in the files," and not easily identified, especially if ALC personnel question "what is to be gained" from going to the effort of researching the costs. Without these alternative costs, the investigation of the Research Propositions is effectively not possible.

In reference to FY80 training funding, correspondence (26) and a DPCT interview (27) indicated that ATC requested 24.4 million dollars for FY80 Type 1 training but received only 9.8 million dollars. In response to ATC requests, AFLC prioritized its 203 outstanding 403s which required Type 1 training in FY80. A priority listing of the top one hundred and three 403s was submitted to ATC for initial funding consideration. ATC in turn advised AFLC that under current funding constraints, only the top fifty AFLC Type 1 requests could be funded.

In an effort to ensure that mission-essential Type 1 training requirements are funded, AFLC/DCS

Maintenance (AFLC/MA) issued instructions for all AFLC installations regarding the use of DMIF funds for procurement of training. The following policy was defined by AFLC/MA and provided to each XX-ALC/DPCT office:

> a. An attempt should be made to have ATC fund all such training. When ATC funds are not available, an attempt will be made where lead time permits to furnish ATC with a fund cite. In the event lead time is not available, an exception to AFR 50-9 will be submitted by message to AFLC/DPCT requesting authority to procure locally the vendor training.
> b. In the event ATC fails to fund a critical maintenance Type 1 training requirement, DMIF funds may be used for that purpose.
> c. Approval to expend these funds will be at the directorate level.
> d. The expenditure of DMIF funds for training will be limited to DMIF employees [15].

In providing the guidance policy, it appears that AFLC is only providing formal authorization to a funding alternative that was already being used by the ALCs, as previously discussed. In any event, the policy does not appear to represent a solution but only a means of coping with the training funding problem; although, AFLC personnel believe it should relieve some of the pressure imposed on the ALCs and reduce the requirement for potentially more expensive CETS or continued contractor support.

The use of DMIF funds, however, may generate long-term problems. Interviews with AFLC/MA personnel (9; 21) provided some insight into the potential impact of training funding on AFLC operations. The DMIF is used by AFLC to fund maintenance operations at the ALCs, including

the cost of labor, materials, and overhead. It is reimbursed from the using commands through the sales rates charged by AFLC for depot actions accomplished. These sales rates are established by AFLC two years in advance and approved at the Office of Secretary of Defense (OSD) level. Therefore, any additional costs incurred by the DMIF in FY80 such as funding for Type 1 training, can only be recovered through increased sales rates established for FY83 depot maintenance (unless OSD approval is received for increases in earlier year sales rates). Approval for use of DMIF funds was made locally by headquarters personnel based on their interpretation of DMIF directives (21). The future impact of DMIF training funding on sales rates, and possibly even the legality of the use of DMIF funds for training funding when reviewed by Air Staff or Congressional committees, remains questionable.

Another action taken by AFLC to cope with the training funding problem concerns the approval of ALC 403s at headquarters level as a prerequisite to submission to ATC (27). As stated in Chapter I, all training requirements for the ALCs are now submitted to ATC through HQ AFLC effective with FY80 training requests. This additional coordination level is intended to ensure that only valid training requirements are submitted to ATC, thereby

minimizing the number of previously mentioned "nice-to-have" requests for training, and enable headquarters personnel to more effectively prioritize command training requirements. To support this headquarters level review process, ALCs will be tasked to provide a detailed impact statement with each 403 submitted. This requirement further supports the objective of this research, as meaningful cost impact information will be required earlier in the planning process. In contrast to developing cost/mission impact statements in reaction to requests from ATC, the ALCs will now have to predict impacts as part of the 403 processing. If a representative model which could be used to predict alternative costs from the estimated training costs can be developed, it could be utilized to support this earlier requirement for cost impact estimates.

Chapter IV presents the conclusions drawn from these Findings and provides recommendations for improvement in fiscal control in the area of training funding. Also, recommendations for further research are provided based on questions identified during this research.

CHAPTER IV

CONCLUSIONS AND RECOMMENDATIONS

Summary

This research effort was initiated to investigate the cost impact on AFLC as a result of a shortage in Type 1 training funds available to ATC. Two research propositions were identified for the study. The first proposition suggested the existence of a positive linear relationship between the estimated cost of unfunded AFLC Type 1 training and the cost to AFLC of implementing alternatives (specifically, CETS or continued contractor support). The second proposition involved the cost effectiveness of these AFLC implemented alternatives and suggested that it would be more cost effective for the Air Force to provide additional ATC funding for Type 1 training then to have AFLC implement alternatives. To test these propositions, a statistical methodology was developed around the basic linear regression model. Data were then gathered on total FY79 AFLC Type 1 training requirements and an attempt was made to compile data on training costs and alternative costs for those Type 1 training requirements which could not be funded by ATC. Problems encountered during the data collection process altered the

research approach and resulted in an investigation of the reasons why these problems may have occurred. Since the data collected was not sufficient to support the proposed statistical tests, a demonstration of the procedures was conducted and included in this report to provide a guideline for further research on the previously described propositions. Also, information on the FY80 Type 1 training funding situation was gained from interviews with HQ AFLC personnel. This information provided additional support for continuation of this research.

The next section of this chapter presents the conclusions of this research effort. The final section presents recommendations to AFLC for improved fiscal control and suggests areas for further research.

Conclusions

The results of this research are heavily dependent upon the responses received during personal and telephone interviews and, hence, may include both fact and personal bias concerning the questions and issues studied. The results of both the ALC written responses and interviews, however, do provide strong circumstantial evidence to suggest that the cost impact of implementing alternatives is a very sensitive area at the ALC level. It appears that ALC functional managers are faced with a dilemma when requested Type 1 training cannot be funded by ATC. If the

training is required to support a valid depot requirement (in contrast to "nice-to-have" training), then the functional manager must seek some other alternative to satisfy at least the current year's depot responsibility. If that alternative is other than an in-house training program (that is, CETS, continued contractor support, or ALC funded training), then it seems reasonable to conclude that the funds used to implement that alternative are unplanned and unbudgeted, and must come from available operating funds. The results suggest that in some cases funds expended are not in accordance with published directives. (This conclusion could not be supported by documented evidence; however, the response was frequently received, especially during informal communications.) The end result, the depot may satisfy its immediate requirement without the aid of Type 1 training.

If the above scenario is accurate, then it may also explain the difficulty in obtaining cost impact data from the ALCs. If funding was not in accordance with directives (for example, ALC contracts for Type 1 training without a waiver to AFR 50-9), then there would be a potential reluctance on the part of the functional managers to provide alternative cost data, or even identify the alternative implemented.

Considering the in-house training alternative, the ALC responses indicated this alternative to be the most frequently used; however, there was some contradiction in the results as to the impact of its use. Training representatives from three ALCs indicated that in-house training is a "make do" effort and does not fully qualify depot personnel or eliminate the need for Type 1 training. Representatives from the remaining two ALCs stated that in-house training frequently satisfies the training requirement and future Type 1 training is no longer required. For this case, an unanswered question arises as to the validity of the original Type 1 training request if in-house training satisfies the need. The results were inconclusive as to the effectiveness of this alternative.

The Headquarters AFLC proposed program to require impact statements with all ALC Type 1 training requests (403s) should help to increase the awareness of personnel at both levels in the command on the impacts of unfunded training. To date, impact statements have been compiled seemingly only in response to ATC requests. Today's increased public concern for defense expenditures necessitates that funds be expended in the most efficient manner. This program should contribute to ensuring that only valid training is requested from ATC, and provide both AFLC and ATC personnel with mission/cost impact information which

can be used in assessing program priority under limited funding conditions.

Recommendations

It is recommended that HQ AFLC require that the ALCs track and maintain cost impact data on all programs for which CETS or continued contractor support is implemented as a result of a negative funding response from ATC (for requested Type 1 training). These figures would provide a data base to support investigation of the research propositions and could be used to support requests for additional Type 1 training funding submitted to Air Staff. In contrast to past funding requests which frequently used estimated cost impact figures, future requests could provide documented cost information which reflects the actual impact of unfunded Type 1 training. Also, the data could be used internally by the ALCs and HQ AFLC to aid in determining the most cost effective alternative to implement in response to future funding shortages. For example, data may indicate that it is more cost effective for the ALC to provide obligation authority to ATC to contract for the necessary Type 1 training than to implement CETS or continued contractor support.

In considering cost impact, an attempt should be made to assess not only the immediate impact of implementing the alternative, that is the contract cost for

CETS or continued contractor support, but also the indirect impacts. For example, if unplanned CETS must be implemented, what other operations or functions in the depot are affected by the diversion of funds to procure CETS, and what is the cost impact on these areas? Although these costs are less tangible than the contract costs, an assessment of these costs would provide a more comprehensive picture of the total cost impact of implementing the alternative. This approach would be applicable to all the alternatives initially posed in Chapter I, and may be especially appropriate in providing some measure of the impact of implementing an in-house training program. To date, it does not appear that the impact of in-house training is really known, except to say that it seems to slow depot response time, since personnel are less skilled than when provided Type 1 training. Also, these lower skill levels may preclude personnel from operating equipment at its full potential, therefore, the Air Force does not receive full return on its investment. Quantifying these effects would provide better information to ATC and AFLC training personnel with which to more accurately assess the impact if a particular training program is not funded, and provide a measure against which other programs of a similar need could be compared.

It is recommended that research be continued on the validity of the research propositions described herein. Also, the following questions are suggested for further study:

1. Is the use of DMIF funds for Type 1 training procurement consistent with published directives and Congressional guidelines?

2. What will be the long-term impact of the use of DMIF funds to support ATC unfunded Type 1 training?

APPENDIXES

APPENDIX A

AFLC/DPC LETTER

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE LOGISTICS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

REPLY TO ATTN OF: DPC

SUBJECT: Fiscal Year 1979 AF Form 403 Information

TO: OC-ALC SM-ALC
OO-ALC WR-ALC
SA-ALC

(Civilian Personnel Officer)

1. Request you provide this office with final status information on FY 80 Type I training identified in Attachment 1 by 15 February 1980.

2. This information is needed to accomplish an AFIT study to investigate the cost impact on AFLC of unfunded Type 1 training. To support this study, information is required on the status of AF Form 403s submitted by your installation for FY 79 training and identified by ATC as Type 1 training. The objective of this study is to relate the estimated cost of unfunded Type 1 training to the cost of implementing alternatives or workaround procedures as a result of insufficient ATC training funds. In order to reduce the work load and impact of this request, all 403s submitted to HQ ATC/TTPP by your installation for FY 79 training were screened to identify those potentially requiring Type 1 training. The 403s identified for Type 2, 3, 4, and/or 5 training by ATC were excluded from the study. The 403s which were identified for Type 1 training or were not identified against a specific type of training comprise the list in Attachment 1.

4. Request that your response provide the following information for each 403 listed (in addition, please include any additional 403s which would enhance the study).

a. Status. Identify the final status of each 403 based on the following definitions:

(1) Deferred (D): Program schedule changed such that training was no longer required in FY 79.

(2) Funded (F): Type 1 training was conducted and funded by ATC.

(3) Unfunded (UF): Type 1 training was required; however, ATC funding was not available to contracting for training (Type 1 training funded by AFLC is considered unfunded for this study).

(4) Satisfied (S): Training requirement was satisfied by types 2, 3, 4 and/or 5 training arranged by ATC.

(5) Other (O): Specify status if above not applicable.

b. If training was unfunded, identify the alternative measures implemented as the result of no training funding by ATC; that is, continued contractor's support (CS), in-house training (IH), Contact Technical Services (CETS), obligation authority to ATC for contracting (OA), ALC contract for training (AT), or other alternatives as applicable.

c. Provide a cost impact using actual costs if applicable due to implementing the above alternatives for each 403 identified as unfunded, and the estimated Type 1 training cost if known.

5. We sincerely regret the additional work load imposed by this request; however, the problems associated with Type 1 training funding levels have plagued all of us for some time. Throughout FY 79, we have taken many actions to improve the funding levels and AFLC/CC has signed several letters to USAF/CSAF and ATC/CC expressing concern and requesting assistance. Based on the severity of the problem and the level of concern, request your assistance in providing this information which may prove beneficial in obtaining additional Type 1 training funds.

6. The AFLC/DPCT contact is Russ Henss, AUTOVON 787-7483, and the AFIT/LS contact is Capt Carl Wiles or Lt John Allen, AUTOVON 785-4437.

FOR THE COMMANDER

Earl A. Aler

1 Atch
AF Form 403 Listing

EARL A. ALER
Directorate of Civilian Personnel
Office of DCS/Personnel

APPENDIX B

OC-ALC RESPONSE

OC-ALC

AF FORM 403	CHECK STATUS					ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
	D	F	UF	S	O			
AOF2-79-043		X						
079	X							
080			X			OA, Hq AFLC Funds	--	$1,358
081	X							
082					X	Contractor not able to provide training during FY 79; can provide training in FY 80.		$15,000 - $20,000
083					X	" "		$15,000 - $20,000
084					X	" "		$15,000 - $20,000
085			X			I H	--	$10,000 - $15,000
089		X						
119					X	Type II Training Not Satisfied		
132			X			C S and I H	Unknown	$15,000 - $20,000
185		X						
186			X			OA, AGMC Newark AFS OH	--	$37,725

OC-ALC (Cont)

AF FORM 403	CHECK STATUS					ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
	D	F	UF	S	O			
AOF2-79-187			X			OA, AGMC Newark AFS OH	--	$37,725
188			X			OA, AGMC Newark AFS OH	--	$37,725
189	X							
190	X							
191		X						
192			X			I H	--	Unknown
193				X				
194			X			I H	--	Unknown
195		X						
196		X						
207			X			I H	--	$10,000 - $15,000
289	X							
294	X							

OC-ALC (Cont)

AF FORM 403	CHECK STATUS					ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
	D	F	UF	S	O			
AOF2-79-327			X			I H	--	Unknown
337			X			I H	--	Unknown
502		X						
536	X							
539	X							
546	X							
548	X							
726			X			I H	--	Unknown
747	X							
748	X							
749			X			I H	--	$10,000
750			X			I H	--	$250
751			X			I H	--	$695

OC-ALC (Cont)

AF FORM 403	CHECK STATUS D	F	UF	S	O	ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
AOF2-79-752			X			I H	--	$2,330
753			X			I H	--	$1,116
757	X							
758		X						
759		X						
760		X						
768			X			C S		
769			X			"		
770			X			"		
771			X			"	$100,000 per man year	$225,000
772			X			"		
773			X			"		
774			X			"		
775			X			"		

OC-ALC (Cont)

AF FORM 403	CHECK STATUS					ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
	D	F	UF	S	O			
AOF2-79-								
776		X						
780		X						
781		X						
796	X							
797	X							
798	X							
800	X							
804	X							
808			X			C S	$550,000	$36,000
811			X			OA, (FY 80) OC-ALC	--	$5,000
823			X			OA, OC-ALC	--	$2,373
836			X			I H	--	Unknown

OC-ALC (Cont)

AF FORM 403	CHECK STATUS D	F	UF	S	O	ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
AOF2-79-837					X	Course to be developed by ATC during FY 80		
840			X			I H	--	$3,000
810			X			OA (FY 80) OC-ALC	--	$5,000
812			X			OA (FY 80) OC-ALC	--	$5,000

APPENDIX C

OO-ALC RESPONSE

Ogden

AF FORM 403	CHECK STATUS D	F	UF	S	O	ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
AOF4-79-07A								
61S		X				14 Nov-5 Dec 78 - Complete Lowry		$480 Tvl Per Diem
61V			X			In house by service contract	$ 4,800	
61W	X					Completed 14 Jan-8 Feb 80		$4,200
61X			X			In house	$ 1,400	
61Y		X				Completed 5 October 1979 In house		
61Z		X				Completed 2 November 1979 In house		
62A		X				Completed 19 October 1979 In house		
62B					X	In house capability through service contract		
62C			X			Requirement outstanding		
71M			X			I H		
72S			X			Received training at Newark		
72Z								

Ogden (Cont)

AF FORM 403	CHECK STATUS					ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
	D	F	UF	S	O			
AOF4-79-74F	X							
74G	X							
74M	X							
74N	X							
74P	X							
74R	X							
74X	X							
75F	X							
75K		X						
75P	X							
76P	X							
76Q	X							
77A	X							

Ogden (Cont.)

AF FORM 403	CHECK STATUS					ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
	D	F	UF	S	O			
AOF4-79-77B		X						
77C	X							
77D			X			In house		
77L		X						
77F		X						
77G	X							
77H	X							
77J	X							
77K		X				Portion of training completed		
77L		X						
77M		X						
77N		X						
77P		X						

AF FORM 403	CHECK STATUS					ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
	D	F	UF	S	O			
AOF4-79-77!	X							
77S		X						
77T			X			In house		
77U			X			In house (TAC)		
77V	X							
77W	X							
542			X			In house		$596.00
543			X			In house		$1,391.00
544			X			In house		$ 798.00
545			X			In house		
547			X			In house		
548			X			In house		
549			X			In house		$ 770.00

Ogden (Cont)

AF FORM 403	CHECK STATUS D	F	UF	S	O	ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
AOF4-79-556			X			In house		$1,235
562			X			A T		$1,450 Tuition $1,004 Tvl/Per Diem
572			X			In house		
722	X							
796	X							
809			X			A T	$45,000,00	
810	X							
817		X						
822			X			Unsatisfactory for Maintenance training		
825		X						
834		X						
836			X			Slipped to FY 81		
837			X			O A		

AF FORM 403	CHECK STATUS					ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
	D	F	UF	S	O			
AOF4-79-838			X			Obligation Authority (OA) to ATC for $5,400 satisfied 403's -837-840	$5,400.	
839			X					
840			X					

APPENDIX D

SA-ALC RESPONSE

San Antonio

AF FORM 403	CHECK STATUS					ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
	D	F	UF	S	O			
AOF3-79-101	X							
102	X							
103	X							
500					X	Course no longer required		
501		X						
502			X					
503	X							
504	X							
505	X							
506	X							
507	X							
508					X	Course no longer required		
509	X							

San Antonio (Cont)

AF FORM 403	CHECK STATUS					ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
	D	F	UF	S	O			
AOF3-79-510			X					$1,200
512			X					$1,000
513			X					
514			X			(CS)	$49,000	$130,000 for AF03-79-514 and 515
515			X			(CS)	$49,000	
516	X							
517					X	Decision to accomplish the workload on a standard prototype work order.		
518		X						
520	X							
521			X					
522			X					
525		X						
526		X						

San Antonio (Cont)

AF FORM 403	CHECK STATUS					ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
	D	F	UF	S	O			
AOF3-79-527		X						
528		X						
529			X					
530			X					
531			X					
532			X					
533			X					
534			X					
535			X					
536			X					
537			X					
538			X					
539			X					

San Antonio (Cont)

AF FORM 403	CHECK STATUS D	F	UF	S	O	ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
AOF3-79-540			X					
541			X					
542			X					
543			X					
544			X					
545		X						
554			X					
555					X	Course no longer required		
556			X					
557			X					
559	X							
560	X							
561	X							

APPENDIX E

SM-ALC RESPONSE

SM-ALC

AF FORM 403	CHECK STATUS D	F	UF	S	O	ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
A0F5-79-080 F-111 Pave Tack			X			Not Accomplished		$5,000
033 Flight Test			X			(AT) Not Accomplished		15,000
112 Sel Assembler (R Jet)			X			Not Accomplished		
113 AN/ALQ-137 (MOD 2960)			X			Not Accomplished		
114 Varian Comp G20 I OP						Training Accomplished Funded By DMIF - FY79	$750	
115 AFSATCOM Depot Maint				X		No Depot Course, Training Satisfied Through Type 4, Org/Inst Maint		
178 A-10 ACES Install				X		Satisfied In-Part By Type 4 In-Part (CETS)		
181 AN/TP81C			X			Tng Accomplished in FY80 Type 2		
188 E3A Teletype			X			Tng Not Received in FY79 Re-Submitted For FY80		
189 E3A Punch Tape Reader			X			Tng Not Received in FY79 Re-Submitted for FY80		
123 E3A AN/UGC129					X	Type 2 Scheduled & Cancelled Due To Delay In Equipment & Support Spares For FY79		
220 Barber-Coleman Controls					X	ATC Deferred To On-Site Type 2 Estimate May 80		
223 AN/TLQ 11			X			Not Accomplished In FY79		

APPENDIX F

WR-ALC RESPONSE

AF FORM 403	CHECK STATUS D	F	UF	S	O	ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
AOF6-79-D28					X	Not funded by ATC for FY 79, not requested for FY 80		
D36					X	" "		
D37					X	Not funded by ATC for FY 79, resubmitted for FY 80		
D28					X	" "		
D39					X	" "		
D01					X	Cancelled by supervisor (F-16 workload transferred)		
D02					X	" "		
D03					X	" "		
D04					X	Cancelled by supervisor		
D07					X	Not funded in FY 79 by ATC, not requested by supv for FY 80		
D08					X	Not funded by ATC - being deferred by supv til later date		
D10					X	Cancelled by supervisor		
D11					X	Not funded by ATC, resubmitted as FY 80 requirement		

WR-ALC (Cont)

AF FORM 403	CHECK STATUS					ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
	D	F	UF	S	O			
AOF6-79-D14					X	Not funded by ATC, not requested by supv for FY 80		
D15	X					Submitted by supv for FY 81		
D16					X	Not funded by ATC, not requested by supv for FY 80		
D17					X	" "		
D19					X	Cancelled by Supv for FY79, resubmitted for FY80		
D20					X	Not funded by ATC for FY 79, resubmitted for FY 80		
D21					X	Not funded by ATC for FY 79, not requested by supv for FY 80		
D22					X	Not funded for FY 79, resubmitted for FY 80		
D23					X	" "		
D24					X	" "		
D25					X	" "		
D26					X	Not funded for FY 79, not requested for FY 80		
D27					X	" "		

AF FORM 403	CHECK STATUS D	F	UF	S	O	ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
AOF6-79-D44					X	Not funded by ATC for FY 79, not requested by supv for FY 80		
D47					X	Not funded by ATC, resubmitted by supv for FY 80		
D48					X	Cancelled by supv		
D50					X	Not funded by ATC for FY 79, resubmitted for FY 80		
D52					X	Not funded by ATC for FY 79, not requested for FY 80		
D100					X	Not funded by ATC for FY 79, resubmitted for FY 80		
H34	X							
H55	X							
H56	X							
H57	X							
H61	X							
H63	X							
L20					X		26 Nov-7 Dec 79 tuition $10,000 paid by DWIF. Approx $4,700 T & PD paid by ATC.	4 people CIASC4Z774-001 $10,000-DWIF $4,700-ATC

WR-ALC (Cont)

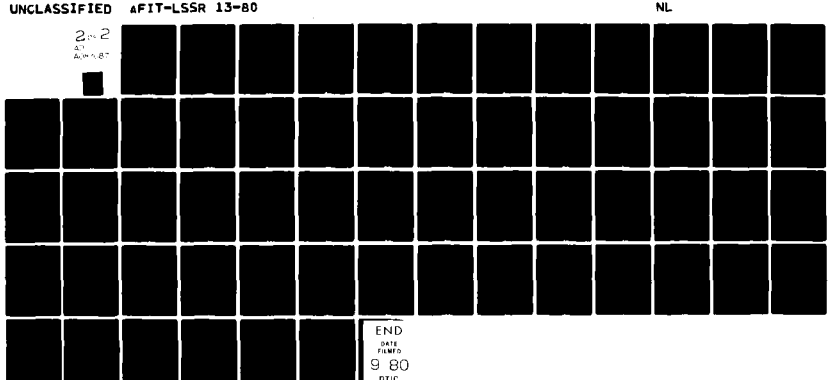
AF FORM 403	CHECK STATUS					ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
	D	F	UF	S	O			
AOF6-79-M01			X			In house training	$2500.	None
R05	X							
R10	X							
R11	X							
R13	X							
R14	X							
R15	X							
R16		X						
R19	X							
R20	X							
R22		X						
R23	X							
R24	X							

WR-ALC (Cont)

AF FORM 403	CHECK STATUS					ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
	D	F	UF	S	O			
AOF6-79-R25	X							
R26	X							
R27	X							
R29	X							
R30	X							
R31	X							
R32	X							
R37	X							
R39		X						
R46	X							
R47	X							
R50	X							
R51	X							

AD-A087 087 AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL--ETC F/G 14/1
COST IMPACT INVESTIGATION OF AFLC UNFUNDED TYPE I (CONTRACTOR) --ETC(U)
JUN 80 J N ALLEN, C J WILES

UNCLASSIFIED AFIT-LSSR 13-80 NL



WR-ALC (Cont)

AF FORM 403	CHECK STATUS					ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
	D	F	UF	S	O			
AOF6-79-R52	X							
R53	X							
R59	X							
R60	X							
R61	X							
R62	X							
R63	X							
R64	X							
R65	X							
R66	X							
R67					X	No requirements- Cancel		
R68					X	No requirements-Cancel		
R69					X	No requirements-Cancel		

AF FORM 403	CHECK STATUS D	F	UF	S	O	ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
AOF6-79-R70	X							
R71	X							
R73					X	No requirement - Cancel		
R83	X							
R84					X	Cancelled		
R85	X							
R86	X							
R87	X							
R88	X							
R89	X							
R90	X							
R91	X							
R92		X						

WR-ALC (Cont)

AF FORM 403	CHECK STATUS					ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
	D	F	UF	S	O			
AOF6-79-R93	X							
R94	X							
R95	X							
R96	X							
R97	X							
W16		X						
AOFU-79-D29					X	Not funded by ATC for FY 79, not requested by supv for FY 80		
D30					X	" "		
D31					X	" "		
D34					X	Not funded by ATC for FY 79, resubmitted for FY 80		
H49	X							
H51	X							
H52		X						

WR-ALC (Cont)

AF FORM 403	CHECK STATUS D	P	UF	S	O	ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
AOFU-79-R06			X			Delay in PMRT no FY 79 impact		
R07			X			" "		
R08			X			" "		
R09			X			" "		
R17			X			" "		
R18			X			" "		
R21	X							
R33			X			Delay in PMRT no FY 79 inpact		
R34			X			" "		
R35			X			" "		
R36			X			" "		
R38			X			" "		
R40	X							

WR-ALC (Cont)

AF FORM 403	CHECK STATUS					ALTERNATIVE IMPLEMENTED IF STATUS IF "UF"	COST IMPACT	ESTIMATED TRAINING COST (IF KNOWN)
	D	F	UF	S	O			
AOFU-79-R41	X							
R42	X							
R45	X							
R54			X			Delay in PMRT - No FY 79 impact		
R55		X						

APPENDIX G

STATISTICAL MODEL SELECTION AND ADAPTATION

This Appendix presents the statistical methodology that was to be used in this research; that is, before it was concluded that the data received were inappropriate for the statistical application. The purpose of presenting the methodology in this report is to provide an explanation of the statistical analysis, which may be used in future research if sufficient data are obtained. In the remainder of this Appendix, it will be assumed that the necessary data have been collected. It will thus be easier to follow the development of the methodology by anyone who actually has the data.

To enhance the understanding of this procedure a demonstration using fictitious data points is provided in Appendix H. This demonstration includes an analysis of the statistical results and representative conclusions.

Model Selection and Adaptation

After completion of the data collection process, investigation of the proposed relationship may begin. There are two categories of relationships between dependent and independent variables: functional relations and statistical relations. In a functional relation, the value of the dependent variable is uniquely determined when the value of the independent variable is specified. In a statistical relation, however, the value of the dependent variable is not uniquely determined by the value

of the independent variable. Rather, the value of the independent variable associates a probability distribution with a range of values for the dependent variable (10:435-436).

The estimated cost (X) of an unfunded training program does not uniquely determine the cost (Y) to AFLC of implementing a particular alternative (population 2 or 3); however, X may be used to determine the expected value of Y, E(Y). Therefore, the appropriate relation to be established for each alternative is a statistical one. A simple linear regression model is used to determine each statistical relation. The explanation which follows applies to both relationships. That is, the statistical procedures are applied to both alternatives in the same manner. The narrative is simplified by discussing a single statistical relation, hereafter referred to as relation, between X and Y.

There are several advantages to using the regression function of the simple linear regression model. One advantage is ease of interpretation. The model has a simple linear equation form, EQ.1; thus, it can be easily applied by planning personnel.

$$E(Y) = \beta_0 + \beta_1 X \qquad \text{EQ.1}$$

where β_0 and β_1 are regression parameters (10:440). Another advantage is the availability of information on

developing and making inferences about the model. Finally, several computer programs have been written to adapt the linear regression model to a given set of data.

The program used in this research is the Regression procedure contained in the Statistical Package for the Social Sciences (SPSS) (11:342), which is available on AFLC's CREATE computer system. The SPSS input file and selected output for the Regression procedure are provided in Appendices H-3 and H-4, respectively. The SPSS output contains the estimated values for β_0 and β_1, b_0 and b_1 respectively, which best fit the model to the data. The regression function (EQ.1) can be estimated by substituting these values into EQ.2, the estimated regression function, which provides a point estimate ($\hat{Y}$) for the expected value of Y (10:446).

$$\hat{Y} = b_0 + b_1X \qquad \text{EQ.2}$$

The output also contains other information, which will be interpreted as needed.

Tests for Aptness

An important point to ponder is the aptness of the linear regression model to the relevant data. Aptness is validated or invalidated by investigating the four assumptions of the linear regression model: linearity, constancy of variance, independence of the residuals, and

normality of the residuals (10:439). A residual, e_i, is the difference between the observed value of Y_i, obtained from input data, and $\hat{Y}_i$, from EQ.2.

$$e_i = Y_i - \hat{Y}_i \quad i=1,2,3,\ldots,N \qquad \text{EQ.3}$$

where N is the number of input data pairs (X_i, Y_i) (10:448). The calculated residuals are used in the aptness investigation by means of residual analysis.

The assumptions of linearity, constancy of variance, and normality are testable in this research. The assumption of independence of residuals is not tested in the aptness of the model since the required time association between variables is not present. Considering that the estimated cost of training and the cost of alternatives are obtained from several agencies within ATC and AFLC respectively, each agency providing cost data for programs for which it is responsible, the assumption of independence seems reasonable.

Residual Scattergram. Linearity is validated by observing a residual scattergram. If the true regression function is linear, the residuals should scatter at random around the value zero. Any scatter pattern other than random indicates nonlinearity of the true regression function; therefore, nonrandomness of the residual scattergram would invalidate the simple linear regression model (10:482). If this occurs, another model would have

to be considered by investigating alternative relationships, such as the exponential or quadratic.

Another use of the residual scattergram is to verify that the residual variance is constant. Nonconstant variance is displayed on the scattergram as a scatter plot with an increasing or decreasing trend in residual magnitude (see Figure 6). Nonconstant residual variance, as nonrandomness, would invalidate the linear regression model (10:482).

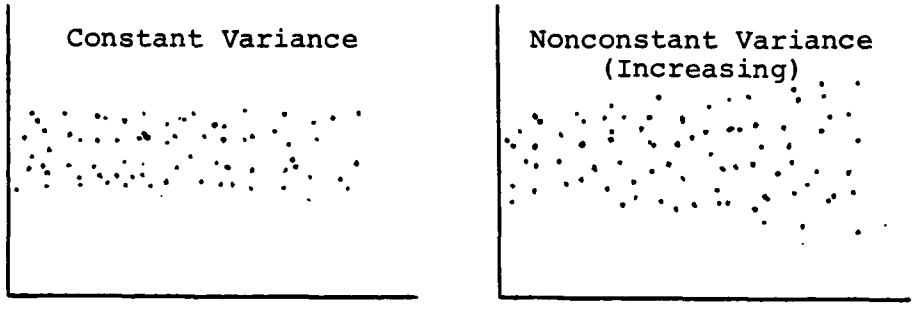


Fig. 6. Scatter Diagrams Showing Constant and Nonconstant Variance

K-S Test. Normality of the residuals is tested using the Kolmogorov-Smirnov (K-S) test (10:403). A special test statistic is used with the K-S test which provides more flexibility in the number of observations required for valid results: the Lilliefores test statistic (3:398). Normality of the residuals is required to validate the linear regression model.

Inferences on the Model

Once the model is shown to be apt, the next step is to make inferences on the model. It is important at the outset to determine the extent of relationship between the independent and dependent variables. A judgmental decision on this relationship can be made by examining the scattergram given in the SPSS output (Appendix H-4). In effect, it can be determined by observation if X and Y are closely related (approaching a functional relationship) or if they are hardly related at all. To aid in this determination, a numerical measure of this extent of relationship is available in the SPSS output (Appendix H-4). This numerical measure is called the coefficient of determination, denoted as r^2. This coefficient is used to express the degree of statistical relationship between the independent variable X and the dependent variable Y. The value of r^2 varies from zero to one. A value of zero implies that there is no relationship between X and Y; that is, X is of no help in predicting Y. On the other hand, a value of one implies a definite relationship between X and Y; that is, perfect predictions of Y can be made from X (10:458). Figure 7 illustrates these two extremes. Obviously, an r^2 equal to one is optimum; however, it is not generally obtainable in practice. For this analysis, a value of r^2 of 0.80 or above is desired, as it will indicate a relatively high degree of linear statistical relation between the estimated training costs and associated alternative costs.

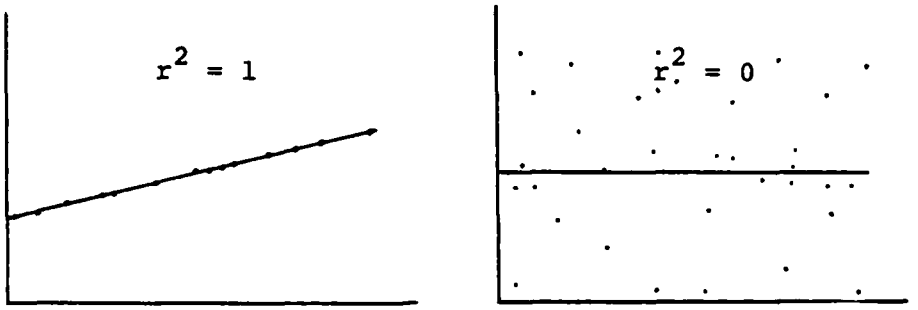


Fig. 7. Scatter Diagrams For $r^2 = 1$ and $r^2 = 0$

The coefficient of determination can be found in the SPSS output under the heading of "R SQUARE" (Appendix H-4, page 119).

As illustrated in Figure 8, there are four possible outcomes for the regression function based upon four possible combinations of β_0 and β_1:

1. $\beta_0 > 0$ and $\beta_1 > 1$
2. $\beta_0 < 0$ and $\beta_1 > 1$
3. $\beta_0 > 0$ and $\beta_1 < 1$
4. $\beta_0 < 0$ and $\beta_1 < 1$

It should be pointed out that the possibility of $\beta_0 < 0$ is a peculiarity of the model and does not imply negative costs. The "equal to" alternatives ($\beta_0 = 0$ and $\beta_1 = 1$)

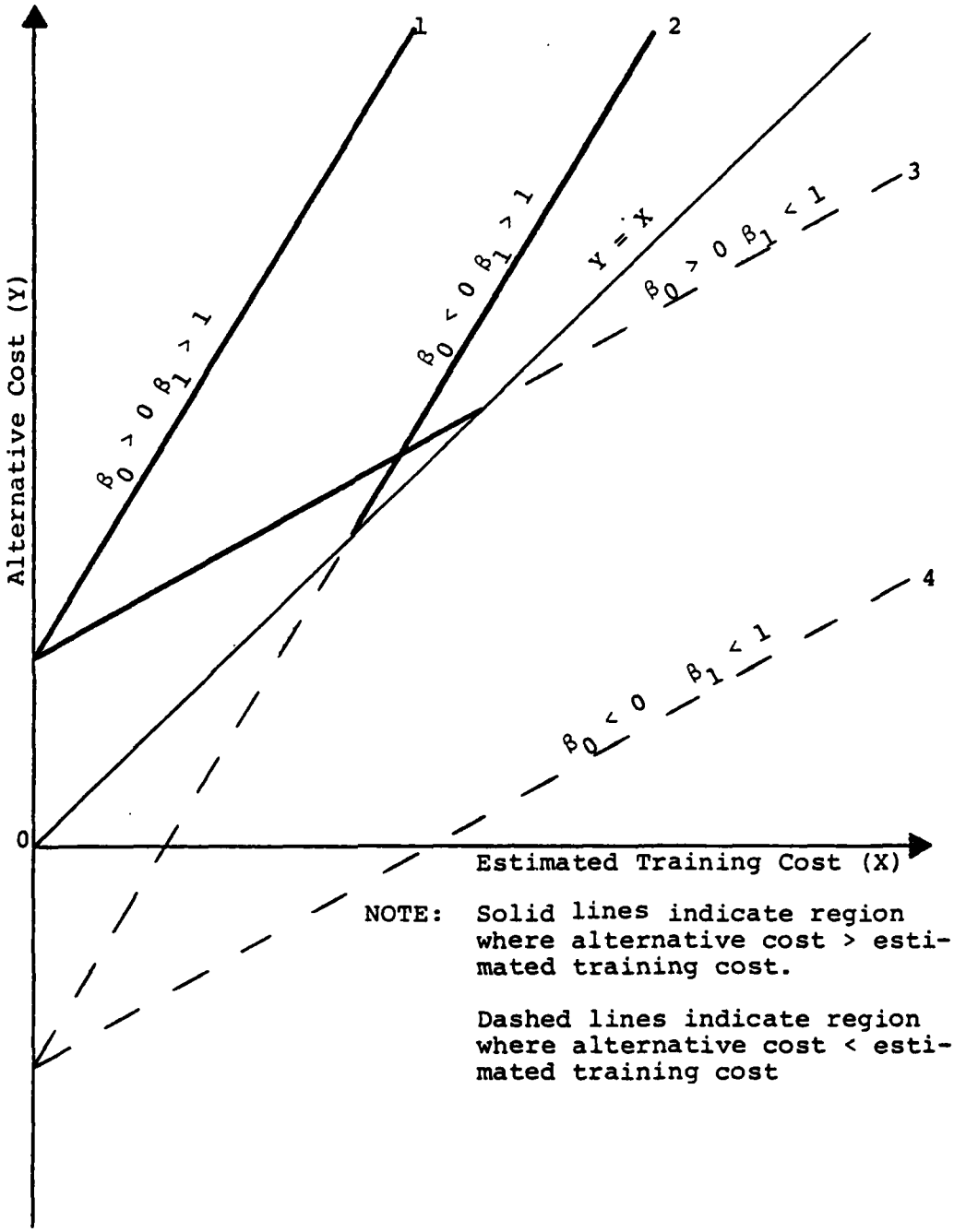


Fig. 8. Four Possible Outcomes for the Regression Function, $E(Y) = \beta_0 + \beta_1 X$

are not considered as possible outcomes since the probability of a continuous random variable having a unique value on the continuum is zero (10:107). In other words, $P(\beta_0 = 0) = P(\beta_1 = 1) = 0$. The significance of the comparison values for β_0 and β_1 (zero and one, respectively) are discussed next.

One of the above four outcomes describes the final regression function and provides information on the relationship between estimated training costs and alternative costs. If it can be shown, with a preselected confidence coefficient of $(1-\alpha)$, that $\beta_1 > 1$, then it can be concluded that a positive linear relationship exists between the estimated training cost and the alternative cost, the first Research Proposition. The symbol α denotes the probability of concluding $\beta_1 > 1$ when actually $\beta_1 < 1$ (10:266). The conclusion of $\beta_1 > 1$ is critical for supporting the first Research Proposition. Thus, it is undesirable to conclude $\beta_1 > 1$ when $\beta_1 < 1$, as this would falsely support the first Research Proposition. The confidence coefficient $(1 - \alpha)$ is the probability of not making the above mentioned error. Therefore, the confidence coefficient is a measure of the "confidence" in the conclusion of $\beta_1 > 1$.

The second Research Proposition is dependent upon the region of the graph in which the function lies; that is, the proposition is only valid for $Y > X$, illustrated in

Figure 8 by the solid portions of the lines. In the region described by the dashed lines, it would be more cost effective to implement the alternative. Therefore, the second Research Proposition is only valid for the first outcome and the region of the second and third outcomes above the line Y = X. Hence, the second Research Proposition is dependent upon the values of β_0 and β_1.

For β_0, the two hypotheses for the decision rule are:

$$H_0: \ \beta_0 \leq 0$$
$$H_1: \ \beta_0 > 0 \qquad \text{EQ.4}$$

The action limit for the decision rule is:

$$A = 0 + t(1-\alpha;\ N-2)\ s(b_0) \qquad \text{EQ.5}$$

The t statistic is found in statistical tables and $s(b_0)$, the standard deviation of the estimator for β_0, is calculated in Appendix H-5. The decision rule for β_0, using its point estimator b_0, is:

$$\text{If } b_0 \leq A, \text{ conclude } H_0$$
$$\text{If } b_0 > A, \text{ conclude } H_1 \qquad \text{EQ.6}$$

Concluding H_1 would infer that $\beta_0 > 0$.

Similarly for β_1 the two hypotheses for the decision rule are:

$$H_0: \ \beta_1 \leq 1$$

$$H_1: \ \beta_1 > 1 \qquad \text{EQ.7}$$

The action limit for the decision rule is shown in EQ.8,

$$A = 1 + t(1-\alpha;\ N-2)\ s(b_1) \qquad \text{EQ.8}$$

and the decision rule is shown in EQ.9.

$$\text{If } b_1 \leq A, \text{ conclude } H_0$$

$$\text{If } b_1 > A, \text{ conclude } H_1 \qquad \text{EQ.9}$$

Concluding H_1 would infer that $\beta_1 > 1$.

If $\beta_1 \leq 1$, an additional test would be required to determine if $\beta_1 > 0$; this test would make inferences on the first Research Proposition. Inferences about the second Research Proposition would depend upon which outcome in Figure 8 is concluded, as previously described.

External Validation

If the first Research Proposition is accepted, the next and final step in the research is validating the model using sample data from subsequent years. In the demonstration which follows in Appendix H, fictitious data

for FY79 are proposed for the Regression procedure and FY80 data are proposed for the external validation of the model. Prediction intervals are computed for each of the FY80 estimated training cost observations. The proposed values of the cost of associated alternatives for FY80 are then tested against the computed prediction intervals; the final results are provided in Appendix H-9. In reality, this validation step may be limited to providing an indication of validity, as data availability may preclude drawing any firm conclusions about the model, which is the case in this example.

It is also pointed out that inferences can only be made about X values which lie within the range of data used to generate the model. Inferences must be applied with considerable judgment if obtained with the model for values of X substantially outside the scope of the model (10:485). This point is further discussed when the concept of updating the model is presented in the procedure conclusions, Appendix H-2.

Assumptions

The following assumptions apply to this procedure:

1. The relationship between estimated training cost and alternative cost established for past data is representative of future years. Inflation and advancements in technology will have the same effects on both

costs, such that the statistical relation remains representative.

2. Any assumptions made by AFLC logistics centers in determining alternative costs extend to this procedure.

3. The assumptions associated with the residuals of the linear regression model also apply:

a. Linearity

b. Constancy of variance

c. Normality

d. Independence

The assumptions of linearity, constancy of variance, and normality, however, are tested in the evaluation of the aptness of the model.

Limitations

The following limitations apply to this procedure:

1. Findings are limited to application to Type 1 training requirements of AFLC only, unless other command program inputs are included in the analysis.

2. The model is only relevant to the alternatives included in the analysis, that is contractor support, CETS, etc.

3. The external validation of the model is limited by data availability.

4. The model is only applicable for values of X within the range of data used in the regression procedure.

Considerable judgment should be used in making inferences when the estimated training cost is substantially outside the scope of the model.

APPENDIX H

DEMONSTRATION OF PROPOSED METHODOLOGY

APPENDIX H-1

INTRODUCTION AND SAMPLE DATA

This appendix is provided to demonstrate the application of the statistical model proposed in Appendix G and serves as a working example which may be used in future research. Computer input and output listings, applicable computations, and an interpretation of the results are included in the following appendices. Hypothetical representative data generated for the demonstration are listed below and represent:

1. The costs for 28 AFLC FY79 unfunded training programs and the associated cost of alternatives implemented by AFLC as a result of no training, and

2. The cost for seven AFLC FY80 unfunded training programs and the associated cost of alternatives implemented by AFLC as a result of no training (for external validation).

1979 SAMPLE COST DATA FOR
REGRESSION ANALYSIS
(All figures in thousands of dollars)

Estimated Cost of Training	Alternative Cost (Cost Impact)
100	700
125	910
145	1100
186	1000
220	1200
231	1200
245	1100
265	1100
272	1250
300	1470
325	1400
343	1260
370	1440
378	1650
404	1640
415	1600
460	1700
480	1540
525	1850
560	1780
600	2100
640	2100
650	2200
680	2150
724	2250
746	2160
780	2300
818	2500

1980 SAMPLE COST DATA FOR EXTERNAL VALIDATION
(All figures in thousands of dollars)

Estimated Cost of Training	Alternative Cost (Cost Impact)
175	1200
247	1280
364	1360
443	1800
485	1675
579	1850
770	2540

APPENDIX H-2

ANALYSIS AND CONCLUSIONS

Data Analysis

The data analysis process begins with a determination of the aptness of the model. This is done through an analysis of a residual scattergram for the assumptions of linearity and constancy of variance and through the use of the K-S test statistic for the assumption of normality of the residuals. The residual scattergram and the K-S test statistic, provided by the program listed in Appendix H-6, are provided as Appendix H-7. The data analysis process continues with inferences about β_0 and β_1 using selected Regression procedure output provided as Appendix H-4. Finally, the external validation of the model is tested through prediction intervals applied to FY80 data.

Aptness. Aptness is of primary concern because all subsequent analysis of and inferences from the model depend on it being valid. As pointed out in Appendix G, the four assumptions of the linear regression model are linearity, constancy of variance, independence of the residuals, and normality of the residuals.

Determination of linearity is a subjective decision based on the residual scattergram shown in Appendix H-7. The apparent randomness of the plotted points indicates a linear relationship between X and Y.

Whether or not the residual variance is constant is another subjective decision based on the residual

scattergram. Nonconstant variance would be indicated by an increasing or decreasing trend of the residuals (see Figure 6). There is no apparent trend on the scattergram; therefore, the implication is constant variance.

Independence of the residuals is assumed. The reasoning is presented in the "Tests for Aptness" section of Appendix G.

The final assumption of the linear regression model is normality of the residuals. The K-S test using the Lilliefores test statistic is used to infer normality. A table of Lilliefores test statistics is provided as Appendix H-8. The Lilliefores test statistic, L, for n=28 (number of observations) and $1 - \alpha = .99$ (99 percent confidence coefficient) is 0.192, by interpolation. The statistic to compare with L is MAX (ABS DIFF) from the K-S Goodness of Fit Test in Appendix H-7. The value of the statistic is 0.1332. The appropriate decision rule for the normality test is

If MAX(ABS DIFF) $\leq$ L, conclude normality

If MAX(ABS DIFF) > L, conclude nonnormality. EQ. 11

Since 0.1332 < 0.192, normality of the residuals is concluded.

The model is determined to be apt as none of the four assumptions of the linear regression model are rejected. Tests may now be performed on the model parameters in order to make inferences on them. Before the tests, however, it

should be noted that the coefficient of determination, r^2, obtained by the Regression procedure (Appendix H-4) of 0.95786 indicates a high degree of linear statistical relationship between estimated training costs and alternative costs. This implies that the relationship derived should provide very good predictions of alternative costs for associated estimated training costs, as initially desired.

Test for β_0. The two hypotheses for the decision rule are:

$$H_0: \quad \beta_0 \leq 0$$

EQ. 4

$$H_1: \quad \beta_0 > 0$$

Using a confidence coefficient of 0.99, the action limit for the decision rule is:

$$A = 0 + t(0.99; 26)\ (43.62027) = 108.13465$$

where $s(b_0)$ is calculated in Appendix H-5.

$b_0 = 642.068$ from Appendix H-4.

Since $b_0 > A$, conclude H_1, that $\beta_0 > 0$.

Test for β_1. The two hypotheses for the decision rule are:

$$H_0: \beta_1 \leq 1 \qquad \text{EQ. 7}$$

$$H_1: \beta_1 > 1$$

Again using a confidence coefficient of 0.99, the action limit for the decision rule is:

$$A = 1 + t(0.99; 26)\ (0.09153) = 1.2269$$

where $s(b_1)$ was obtained from Appendix H-4.

$b_1 = 2.22508$ from Appendix H-4.

Since $b_1 > A$, conclude H_1, that $\beta_1 > 1$.

Concluding H_1 for β_0 and β_1 infers that both Research Propositions are correct. The first Research Proposition is dependent upon β_1 being greater than zero. The second Research Proposition required that β_1 be greater than one and the function lie in the region of the graph (Figure 8) above the line Y=X. The above conclusions for β_0 and β_1 indicate that outcome 1 of Figure 8 is the representative line for the regression function, which is estimated by EQ. 2 as follows:

$$\hat{Y} = 642.068 + 2.225X. \qquad \text{EQ. 10}$$

External Validation. The final step in the analysis is the external validation of the model. Data for this step consist of the costs associated with seven

hypothetical Type 1 training programs identified as unfunded in FY80 and the associated alternative costs. The model is tested by computing a prediction interval for each estimated training cost and comparing this interval with the proposed alternative cost. The input data and results for these computations are provided in Appendix H-9.

As indicated in Appendix G, this validation step is limited to providing an indication of validity as the availability of data for FY80 precludes any detailed analysis of the model. The results in Appendix H-9 do indicate the model's validity, as the actual value for alternative cost falls within the computed prediction interval for every data pair tested.

Conclusions

The analysis of the hypothetical FY79 data implies that indeed a positive linear relationship does exist between the estimated cost of AFLC unfunded Type 1 training and the cost of alternatives implemented as a result of no training. More specifically, the cost impact of implementing CETS or continued contractor support as a substitute for an organic depot capability can be related to the estimated training cost by the following estimated regression function:

$$\hat{Y} = 642.068 + 2.225X \qquad \text{EQ. 10}$$

Inferences on β_0 and β_1, the regression function coefficients, indicate that it can be concluded with 99 percent confidence that $\beta_0 > 0$ and $\beta_1 > 1$. This conclusion places the regression function totally in the region of the graph (Figure 8) where the alternative costs exceed the estimated training costs. This supports the second proposition; that is, it would be more cost effective for the Air Force to provide additional funds to ATC to satisfy AFLC training requirements than to have AFLC implement alternatives.

The validity of the model, however, is still not established with certainty as the availability of FY80 data permitted only a demonstration of validity. Also, it is important to reiterate the assumption that FY79 data are representative of future years. Therefore, initial implementation of the model by planning personnel should be done with caution and judgment while more conclusive evidence of validity is collected.

It is anticipated that the model may require updating as the effects of inflation and advancements in the state-of-the-art alter the relationship. This updating process would be very similar to that used in this demonstration, with FY79 data replaced by more current data. The use of more current data would also extend the range of usefulness of the model in a changing economy. Recalling the point made under

"External Validation" in Appendix G, inferences about alternative costs can only be made about X values which lie within the range of data used to generate the model. Therefore, updating the model will help to ensure that the range of values of X for which the model is valid is representative of then year estimated training costs. It is emphasized that inferences must be applied with considerable judgment if obtained with the model for values of X substantially outside the scope of the model (10:485).

APPENDIX H-3

SPSS REGRESSION PROCEDURE PROGRAM AND DATA INPUT FILE

```
1000##S,R(SL) :,8,16;;,16
1005$:IDENT:WP1186,AFIT/SLSC J ALLEN 80
1010$:SELECT:SPSS/SPSS
1015RUN NAME;REGRESSION ANALYSIS FOR THESIS DATA
1020VARIABLE LIST;ESTCOST,ALTCOST
1025INPUT FORMAT;FREEFIELD
1030INPUT MEDIUM;CARD
1035N OF CASES;28
1036LIST CASES;CASES=28/VARIABLES=ESTCOST,ALTCOST/
1040REGRESSION;VARIABLES=ESTCOST,ALTCOST/
1045;REGRESSION=ALTCOST WITH ESTCOST(2) RESID=0
1050STATISTICS;1,2,4,5,6
1055READ INPUT DATA
1056$:SELECTA:80A054/TRAIN,R
1140SCATTERGRAM;ALTCOST WITH ESTCOST
1141OPTIONS;7
1160FINISH
1165$:ENDJOB
```

```
100 100 700
110 125 910
120 145 1100
130 186 1000
140 220 1200
150 231 1200
160 245 1100
170 265 1100
180 272 1250
190 300 1470
200 325 1400
210 343 1260
220 370 1440
230 378 1650
240 404 1640
250 415 1600
260 460 1700
270 480 1540
280 525 1850
290 560 1780
300 600 2100
310 640 2100
320 650 2200
330 680 2150
340 724 2250
350 746 2160
360 780 2300
370 818 2500
```

APPENDIX H-4

SPSS REGRESSION PROCEDURE
SELECTED OUTPUT

FILE NONAME (CREATION DATE = 05/02/88)

VARIABLE	MEAN	STANDARD DEV	CASES
FSTCOST	428.1071	213.2685	28
ALTCOST	1594.6429	484.8481	28

REGRESSION ANALYSIS FOR THESIS DATA 05/02/88 PAGE 5

FILE NONAME (CREATION DATE = 05/02/88)

• M U L T I P L E R E G R E S S I O N • • • • • • • • • • • • • VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. ALTCOST

VARIABLE(S) ENTERED ON STEP NUMBER 1.. ESTCOST

MULTIPLE R	0.97870	ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F
R SQUARE	0.95786	REGRESSION	1.	6079633.69224	6079633.69224	591.88888
ADJUSTED R SQUARE	0.95624	RESIDUAL	26.	267462.73633	10287.82832	
STANDARD ERROR	101.42499					

---------- VARIABLES IN THE EQUATION ----------

VARIABLE	B	BETA	STD ERROR B	F
ESTCOST	2.2258843	0.97870	0.09153	591.888
(CONSTANT)	442.8683593			

---------- VARIABLES NOT IN THE EQUATION ----------

VARIABLE	BETA IN	PARTIAL	TOLERANCE	F

MAXIMUM STEP REACHED

STATISTICS WHICH CANNOT BE COMPUTED ARE PRINTED AS ALL NINES.

REGRESSION ANALYSIS FOR THESIS DATA 05/02/88 PAGE 6

FILE NONAME (CREATION DATE = 05/02/88)

• M U L T I P L E R E G R E S S I O N • • • • • • • • • • • • • VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. ALTCOST

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
ESTCOST	0.97870	0.95786	0.95786	0.97870	2.2258843	0.97870
(CONSTANT)					442.8683593	

FILE NONAME (CREATION DATE = 05/02/86)

• M U L T I P L E R E G R E S S I O N • • • • • • • • • • • • • • •

DEPENDENT VARIABLE ALTCOST FROM VARIABLE LIST 1
REGRESSION LIST 1

SEQNUM	OBSERVED ALTCOST	PREDICTED ALTCOST	RESIDUAL	PLOT OF STANDARDIZED RESIDUAL -2.0 -1.0 0.0 1.0 2.0
1	700.0000	864.5768	-164.5768	
2	918.0000	928.2630	-10.28398	
3	1100.000	964.7856	135.2944	
4	1000.000	1055.934	-55.93485	
5	1200.000	1131.587	68.41389	
6	1200.000	1156.863	43.93716	
7	1100.000	1187.214	-87.21482	
8	1100.000	1231.716	-131.7157	
9	1250.000	1247.291	2.708781	
10	1470.000	1389.594	168.4063	
11	1400.000	1365.221	34.77923	
12	1260.000	1405.272	-145.2723	
13	1440.000	1465.358	-25.34956	
14	1650.000	1483.154	166.8498	
15	1640.000	1541.002	98.99757	
16	1600.000	1565.478	34.52144	
17	1700.000	1665.607	34.392R5	
18	1540.000	1718.109	-178.1088	
19	1850.000	1810.238	39.76236	
20	1700.000	1888.116	-188.1156	
21	2100.000	1977.119	122.8810	
22	2100.000	2066.122	33.87767	
23	2200.000	2088.373	111.6268	
24	2150.000	2155.126	-5.125708	
25	2250.000	2253.829	-3.829419	
26	2160.000	2301.981	-141.9813	
27	2300.000	2377.634	-77.63414	
28	2500.000	2462.187	37.81265	

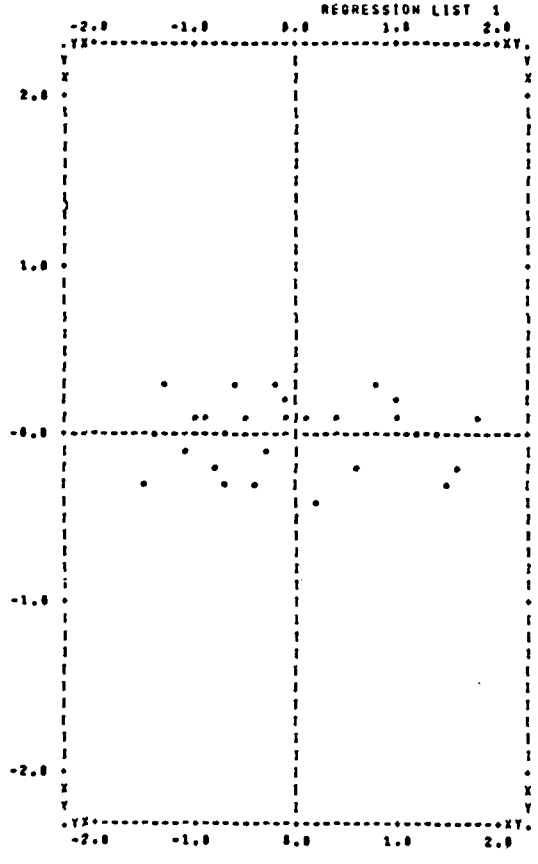
DURBIN-WATSON TEST OF RESIDUAL DIFFERENCES COMPARED BY CASE ORDER (SEQNUM).
VARIABLE LIST 1, REGRESSION LIST 1. DURBIN-WATSON TEST 1.84514

REGRESSION ANALYSIS FOR THESIS DATA 05/02/88 PAGE 9

FILE NONAME (CREATION DATE = 05/02/88)

* * * * * * * PLOT STANDARDIZED RESIDUAL (DOWN) -- PREDICTED STANDARDIZED DEPENDENT VARIABLE (ACROSS) * * * *

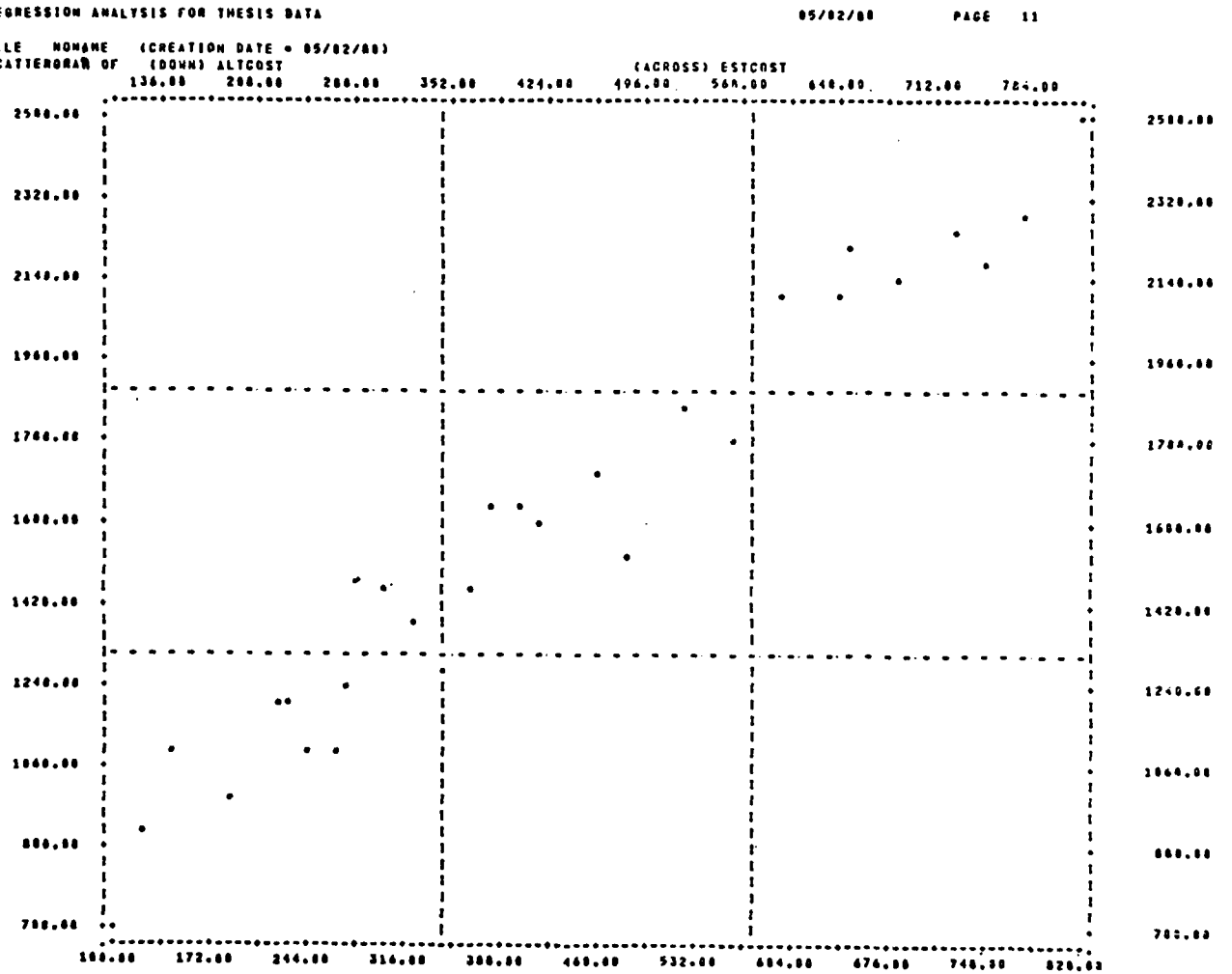
DEPENDENT VARIABLE ALTCOST VARIABLE LIST 1
REGRESSION LIST 1



ROWS,COLUMNS Y VALUES OUTSIDE (-3.0,3.0) ROWS,COLUMNS X VALUES IN (-3.0,-2.05) OR (2.05,3.0)

REGRESSION ANALYSIS FOR THESIS DATA 05/02/88 PAGE 11

FILE NONAME (CREATION DATE = 05/02/88)



APPENDIX H-5

COMPUTATION OF $s(L_0)$

The value for $s(b_0)$ is computed from the following equation:

$$s^2(b_0) = MSE \left[\frac{1}{N} + \frac{\bar{X}^2}{\sum_{i=1}^{N} (X_i - \bar{X})^2}\right] \qquad (10:479)$$

Using appropriate data from the Regression output in Appendix H-4, the value for MSE is found on page 119 under the dual headings MEAN SQUARE - RESIDUAL. The value for X is found on page 118 under the dual headings MEAN-ESTCOST. The values for the constant variables are listed below along with the calculuated values for $s^2(b_0)$ and $s(b_0)$.

N = 28 (number of cases)

MSE = 10287.028

$\bar{X}$ = 428.107

$s^2(b_0)$ = 1,902.728

and

$s(b_0)$ = 43.62027.

APPENDIX H-6

SPSS SCATTERGRAM/K-S
TEST PROGRAM

```
1000##S,R(SL) :,8,16;;,16
1005$:IDENT:WP1186,AFIT/LS ALLEN WILES
1010$:SELECT:SPSS/SPSS
1015RUN NAME;THESIS RESIDUAL ANALYSIS
1020VARIABLE LIST;PRED,RESD
1025INPUT FORMAT;FREEFIELD
1030N OF CASES;28
1035SCATTERGRAM;RESD(-175,175) WITH PRED(850,2500)
1040READ INPUT DATA
1045 864.577 -164.577
1050 920.204 -10.204
1055 964.706 135.294
1060 1055.934 -55.934
1065 1131.587 68.413
1070 1156.063 43.937
1075 1187.214 -87.214
1080 1231.716 -131.716
1085 1247.291 2.709
1090 1309.594 160.406
1095 1365.221 34.779
1100 1405.272 -145.272
1101 1465.350 -25.350
1102 1483.150 166.850
1103 1541.002 98.998
1104 1565.478 34.522
1105 1665.607 34.393
1106 1710.109 -170.109
1107 1810.238 39.762
1108 1888.116 -108.116
1109 1977.119 122.881
1110 2066.122 33.878
1111 2088.373 111.627
1112 2155.126 -5.126
1113 2253.029 -3.029
1114 2301.981 -141.981
1115 2377.634 -77.634
1116 2462.187 37.813
1120NPAR TESTS;K-S(NORMAL)=RESD
1125CONDESCRIPTIVE;RESD
1130STATISTICS;ALL
1135FINISH
9999$:ENDJOB
```

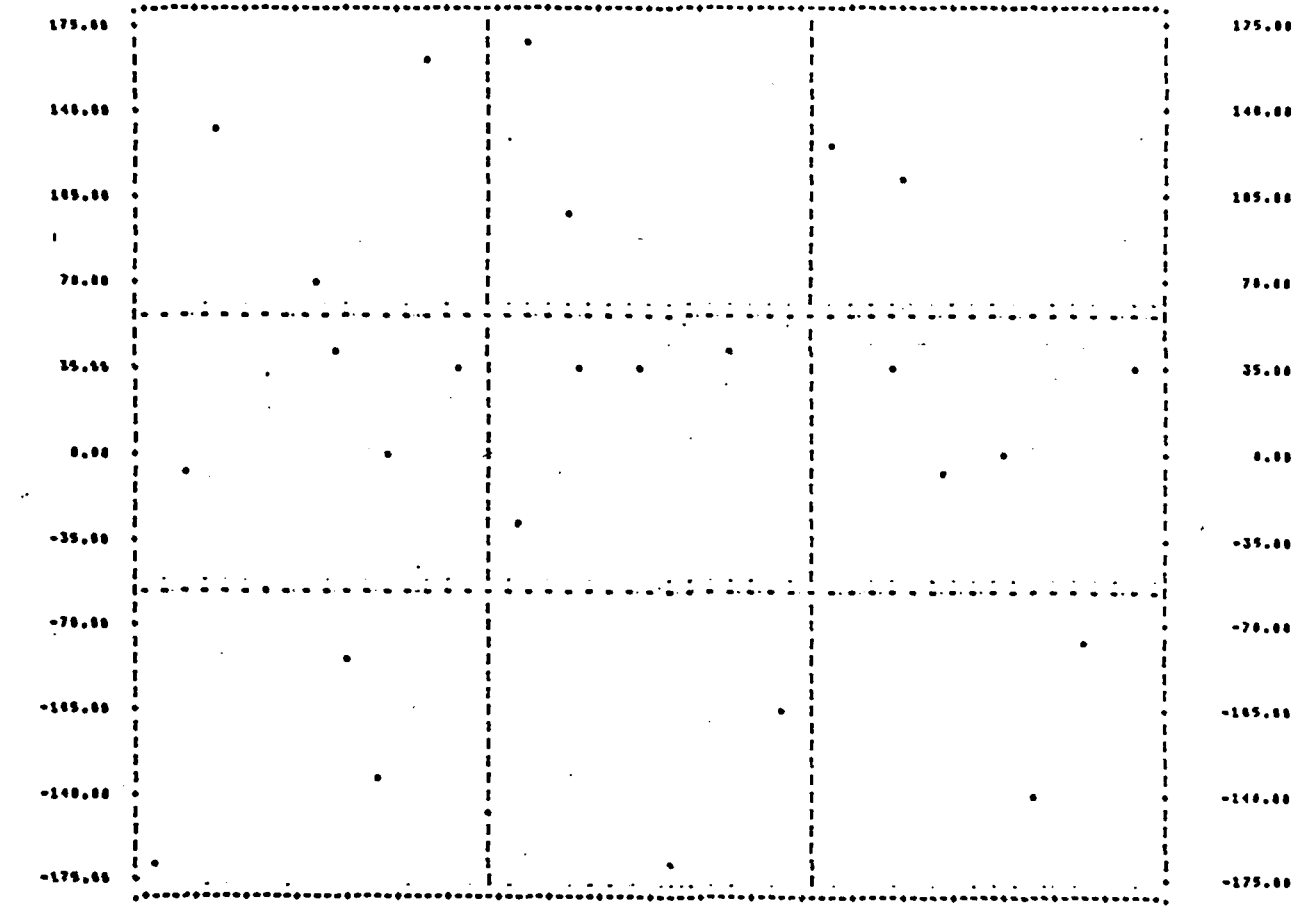
APPENDIX H-7

SPSS SCATTERGRAM/K-S TEST
SELECTED OUTPUT

THESIS RESIDUAL ANALYSIS 04/29/88 PAGE 2

FILE NONAME (CREATION DATE = 04/29/88)

SCATTERGRAM OF (DOWN) RESD (ACROSS) PRED



THESIS RESIDUAL ANALYSIS 04/29/88 PAGE 5

FILE NONAME (CREATION DATE = 04/29/88)

- - - - - KOLMOGOROV - SMIRNOV GOODNESS OF FIT TEST

RESD
TEST DIST. = NORMAL (MEAN = 0.0000 STD. DEV. = 99.5298)

CASES	MAX(ABS DIFF)	MAX(+ DIFF)	MAX(- DIFF)
28	0.1332	0.0857	-0.1332

K-S Z	2-TAILED P
0.705	0.703

THESIS RESIDUAL ANALYSIS 04/29/88 PAGE 7

FILE NONAME (CREATION DATE = 04/29/88)

VARIABLE RESD

MEAN	0.000	STD ERROR	18.809	STD DEV	99.529
VARIANCE	9906.031	KURTOSIS	-0.888	SKEWNESS	-0.163
RANGE	336.959	MINIMUM	-170.109	MAXIMUM	166.850
SUM	0.000				

VALID OBSERVATIONS = 28 MISSING OBSERVATIONS = 0

APPENDIX H-8

LILLIEFOR'S TEST STATISTIC TABLE

QUANTILES OF THE LILLIEFORS TEST STATISTIC

	p=.80	.85	.90	.95	.99
Sample size n=4	.300	.319	.352	.381	.417
5	.285	.299	.315	.337	.405
6	.265	.277	.294	.319	.364
7	.247	.258	.276	.300	.348
8	.233	.244	.261	.285	.331
9	.223	.233	.249	.271	.311
10	.215	.224	.239	.258	.294
11	.206	.217	.230	.249	.284
12	.199	.212	.223	.242	.275
13	.190	.202	.214	.234	.268
14	.183	.194	.207	.227	.261
15	.177	.187	.201	.220	.257
16	.173	.182	.195	.213	.250
17	.169	.177	.189	.206	.245
18	.166	.173	.184	.200	.239
19	.163	.169	.179	.195	.235
20	.160	.166	.174	.190	.231
25	.142	.147	.158	.173	.200
30	.131	.136	.144	.161	.187
Over 30	$\frac{.736}{\sqrt{n}}$	$\frac{.768}{\sqrt{n}}$	$\frac{.805}{\sqrt{n}}$	$\frac{.886}{\sqrt{n}}$	$\frac{1.031}{\sqrt{n}}$

SOURCE: 3:398

APPENDIX H-9

EXTERNAL VALIDATION

A 95 percent two-sided prediction interval for the actual alternative cost (Y_h) as a result of FY80 unfunded Type 1 training is computed for each value of associated estimated training cost (X_h) below. ($\hat{Y}_h$ is the predicted value, from EQ.2).

$$Y_h = \hat{Y}_h \pm t(1-\alpha/2;\ N-2)\ s(d_h) \qquad (10:472)$$

$$Y_h = \hat{Y}_h \pm t(0.975,\ 26)\ s(d_h)$$

where $\hat{Y}_h$ was computed for each value X_h using EQ. 10, and $s(d_h)$ was computed from

$$s^2(d_h) = MSE\ \left[1 + \frac{1}{N} + \frac{(X_h - \bar{X})^2}{\sum_{i=1}^{N} (X_i - \bar{X})^2}\right] \qquad (10:471)$$

using data from the SPSS Regression output (Appendix H-4).

The following listing represents the FY80 estimated training costs, the associated alternative costs, and the results of the above computations:

ALTERNATIVE COST ACTUAL COMPARED TO
PREDICTION INTERVAL

(Costs x $1,000)

Fiscal Year 80

Estimated Training Cost	Alternative Cost (Actual)	Alternative Cost (Predicted)	95% Prediction Interval
175	1,200	1,031.458	813.958 - 1,248.958
247	1,280	1,191.664	976.724 - 1,406.604
364	1,360	1,451.999	1,239.436 - 1,664.563
443	1,800	1,627.781	1,415.541 - 1,840.020
485	1,675	1,721.234	1,508.744 - 1,933.725
579	1,850	1,930.392	1,716.280 - 2,144.504
770	2,540	2,355.383	2,133.625 - 2,577.141

NOTE: In all cases demonstrated, actual alternative cost is within the computed prediction interval.

APPENDIX I

AUTOVON DIRECTORY FOR OFFICES REFERENCED IN THIS RESEARCH

Office Symbol	Personnel Referenced	Autovon
AFALD/CV	Maj General Charles L. Wilson	785-6314
AFLC/CC	General Bryce Poe, II.	787-6033
AFLC/DPCT	Spencer N. Roads, GS-14 Russell E. Henss, GS-13 Thomas J. Vacchiano, GS-9	787-4483
AFLC/LOMAT	Robert S. Darden, GS-12	787-2526
AFLC/MAJA	John F. Stallings, GS-12	787-7771
AFLC/MASR	Major Donald A. Mates	787-4687
ATC/CC	General John W. Roberts	487-5512
ATC/CV	Maj General Evan W. Rosencrans	487-5512
ATC/TT	Brig General Mele Vojvodich, Jr.	487-4521
ATC/TTY	Colonel Robert F. Brodman	487-3366
ATC/TTYA	Lt Colonel Dale L. Norman Jackie R. Stewart, GS-12	487-3176
OC-ALC/DPCT	Max D. Hire, GS-12	735-7537
OO-ALC/DPCT	Jack V. Smith, GS-13	458-7665
SA-ALC/DPCT	Leroy E. Sebesta, GS-11	945-7504
SM-ALC/DPCT	Barry G. Hillier, GS-12	633-6294
USAF/MPPT	Colonel Donald F. Brackett	225-2445
WR-ALC/DPCT	Leverett S. Reed, GS-12	468-2092

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